US009785230B2

(12) **United States Patent**
Goetgeluk

(10) **Patent No.: US 9,785,230 B2**
(45) **Date of Patent: *Oct. 10, 2017**

(54) **LOCOMOTION SYSTEM AND APPARATUS**

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(72) Inventor: **Jan Goetgeluk**, Houston, TX (US)

(73) Assignee: **Virtuix Holdings Inc.**, Austin, TX (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **15/088,568**

(22) Filed: **Apr. 1, 2016**

(65) **Prior Publication Data**

US 2016/0216759 A1 Jul. 28, 2016

Related U.S. Application Data

(63) Continuation of application No. 14/062,625, filed on Oct. 24, 2013, now Pat. No. 9,329,681.

(60) Provisional application No. 61/717,761, filed on Oct. 24, 2012, provisional application No. 61/757,986, filed on Jan. 29, 2013.

(51) **Int. Cl.**

A63G 31/16	(2006.01)
G06F 3/01	(2006.01)
A63B 69/00	(2006.01)
A63B 71/06	(2006.01)
A63F 13/00	(2014.01)
A63B 24/00	(2006.01)

(52) **U.S. Cl.**

CPC ***G06F 3/011*** (2013.01); ***A63B 69/0035*** (2013.01); ***A63B 69/0064*** (2013.01); ***A63B 71/0622*** (2013.01); ***A63G 31/16*** (2013.01); *A63B 2024/0096* (2013.01); *A63B 2069/0037* (2013.01); *A63B 2071/0638* (2013.01); *A63B 2210/50* (2013.01); *A63B 2220/10* (2013.01); *A63B 2220/12* (2013.01); *A63B 2220/40* (2013.01); *A63B 2220/805* (2013.01); *A63B 2225/093* (2013.01); *A63B 2225/50* (2013.01); *G06F 2203/012* (2013.01)

(58) **Field of Classification Search**

CPC A63B 19/00; A63B 19/04; A63B 24/00; A63F 9/00; A63F 13/00; A63F 13/06; G06F 3/00; G06F 3/01; G06F 17/00; G06F 19/00

USPC 472/59, 60, 61, 130; 434/34, 55; 463/30–31, 34, 36–39; 345/156, 157, 345/163–166

See application file for complete search history.

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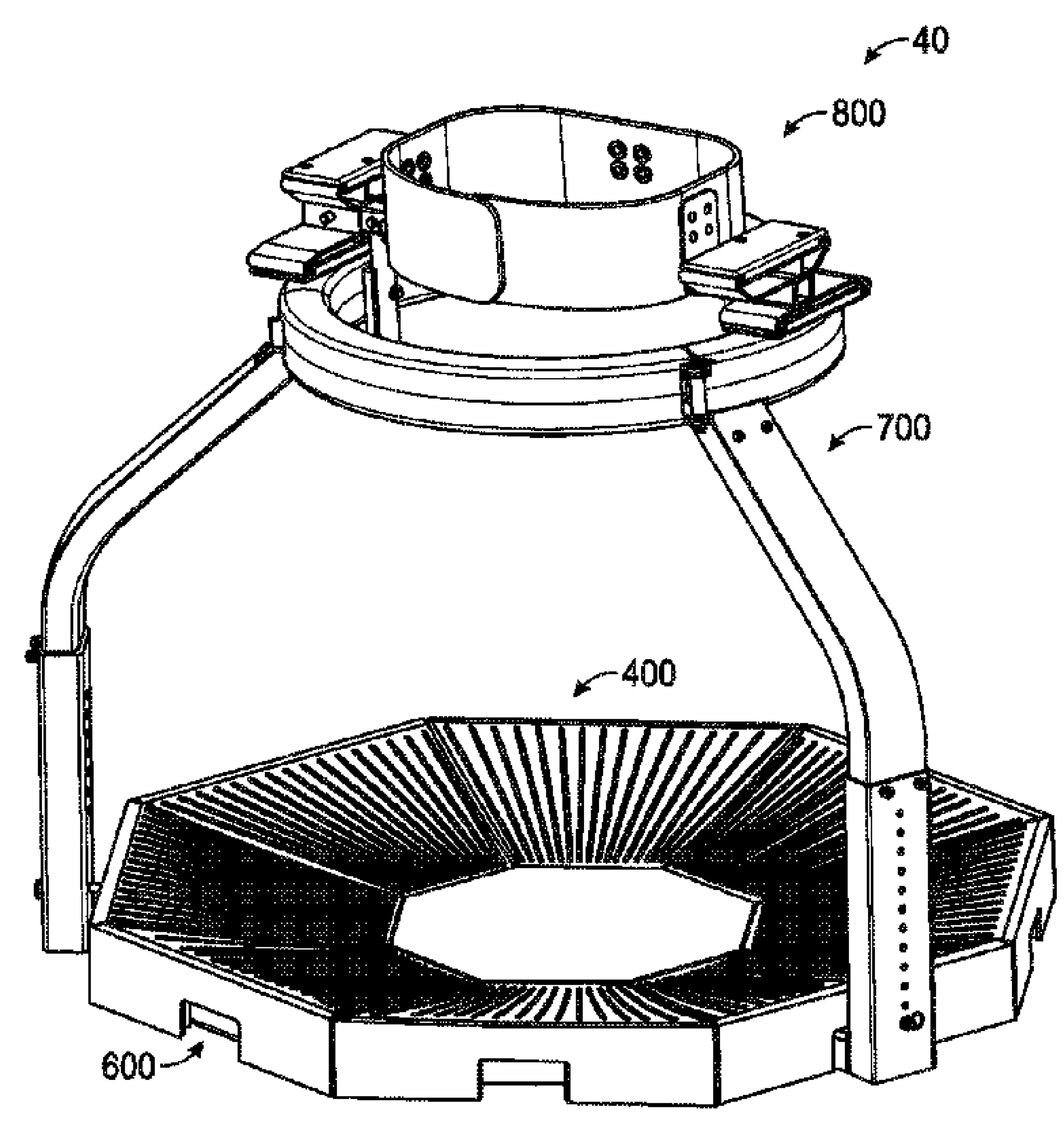
Primary Examiner — Kien Nguyen
(74) *Attorney, Agent, or Firm* — Polsinelli PC

(57) **ABSTRACT**

A locomotion system for use with a virtual environment technology includes a platform configured to support a user, a harness support assembly coupled to the platform and extending upwardly from the platform, and a safety harness configured to be worn by the user. The harness support assembly includes a support halo positioned above the platform and extending about a vertical central axis. The safety harness includes an interface structure moveably coupled to the support halo.

40 Claims, 28 Drawing Sheets



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2009/0111670	A1 *	4/2009	Williams	A63B 23/0464 482/146

* cited by examiner

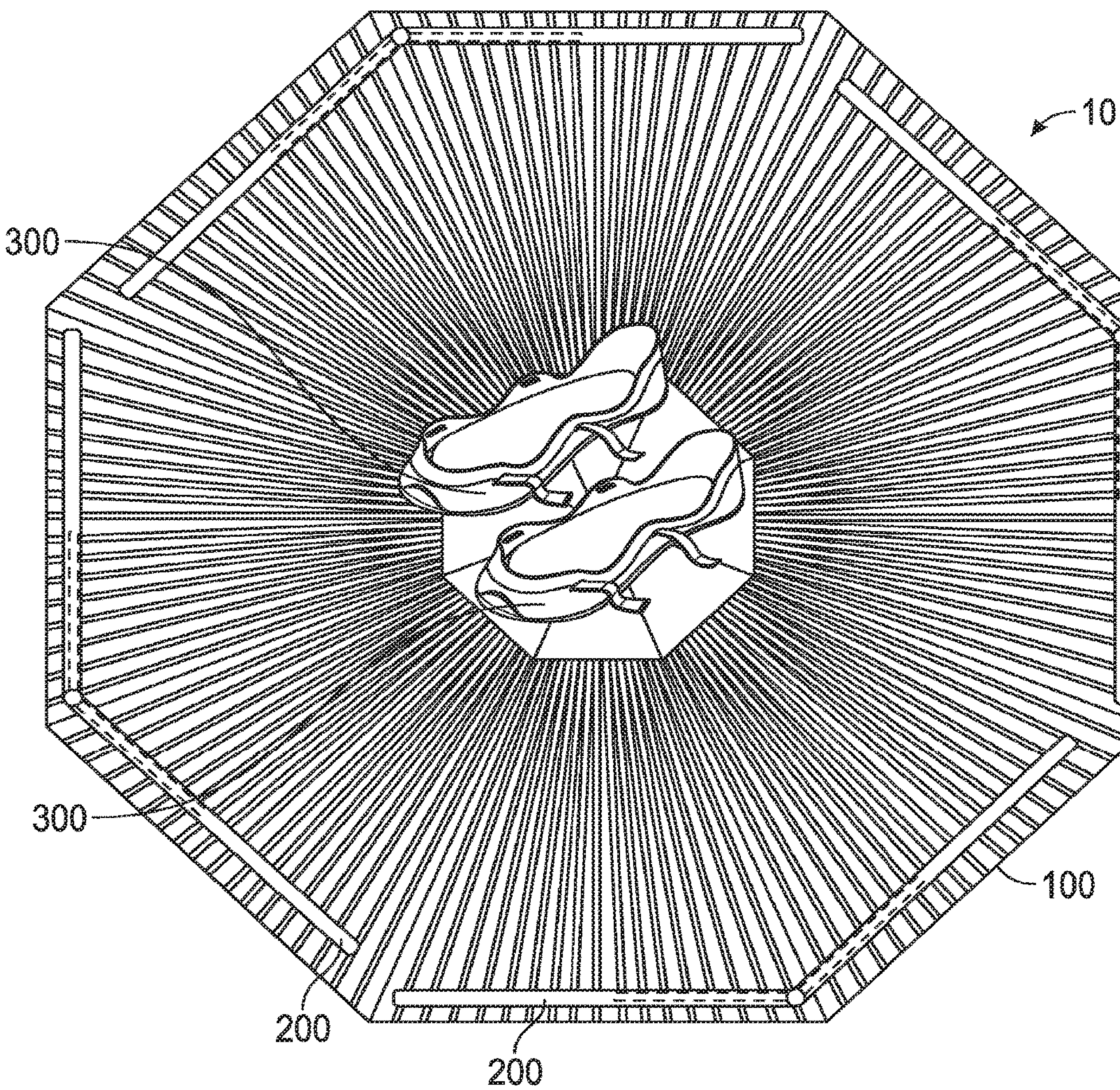


FIG. 1

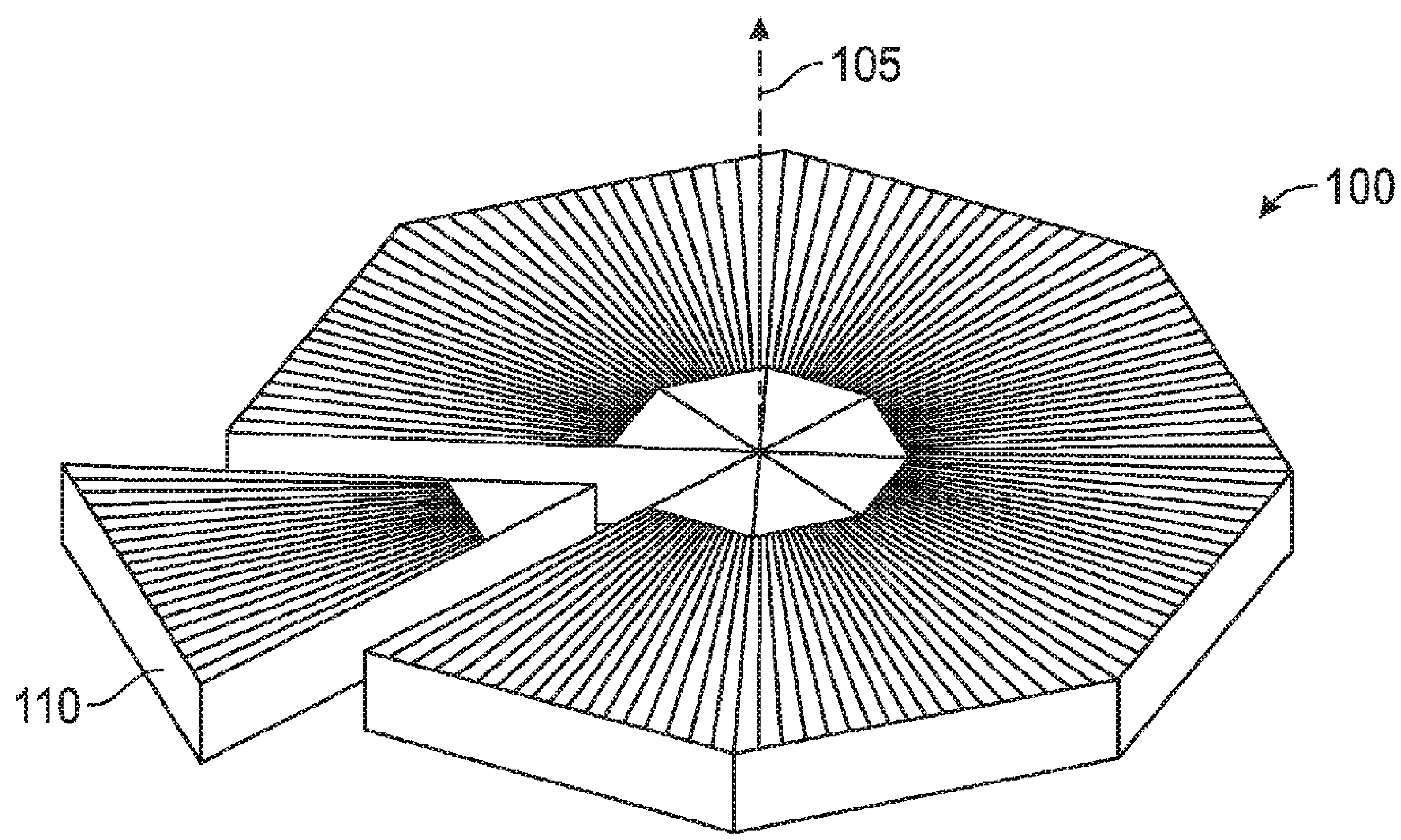

105
100
110

FIG. 2

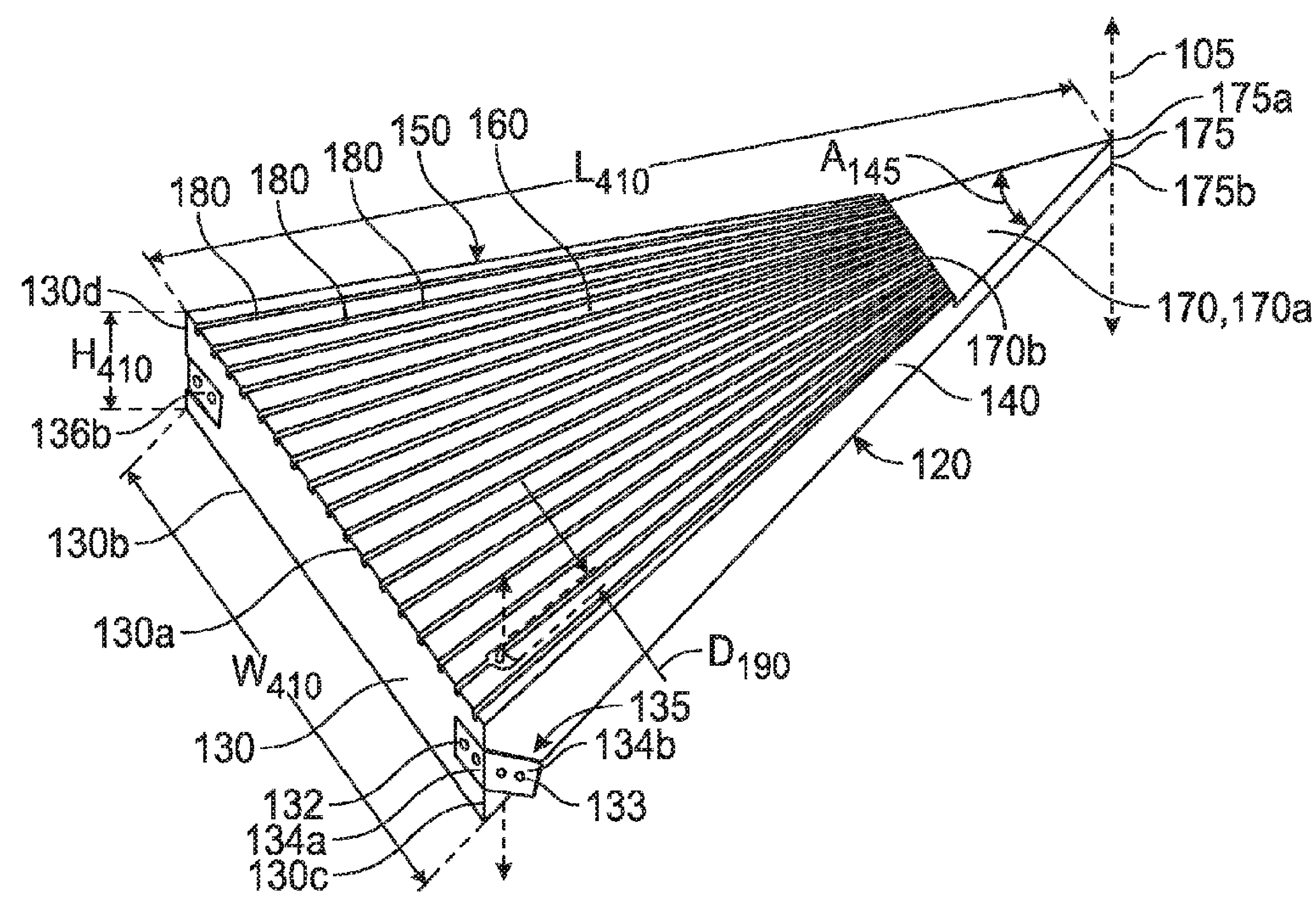

105
175a
175
175b
A_{145}
L_{410}
150
160
180
180
180
180
130d
H_{410}
136b
170,170a
170b
140
120
130b
130a
D_{190}
W_{410}
135
134b
130
133
132
134a
130c

FIG. 3A

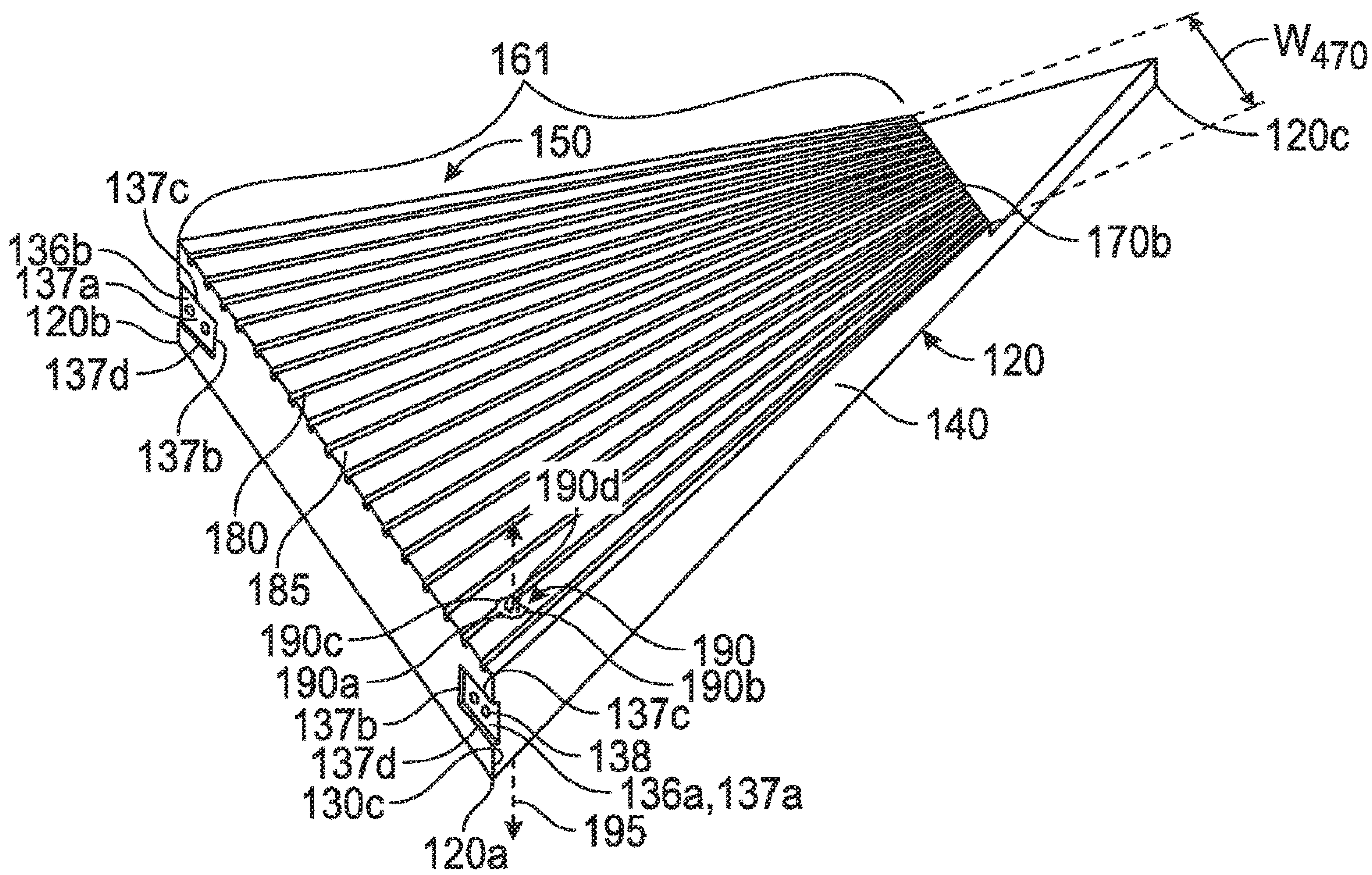

161
150
W_{470}
120c
137c
136b
137a
120b
137d
170b
120
140
137b
180
185
190d
190c
190
190a
190b
137b
137c
137d
138
130c
136a,137a
120a
195

FIG. 3B

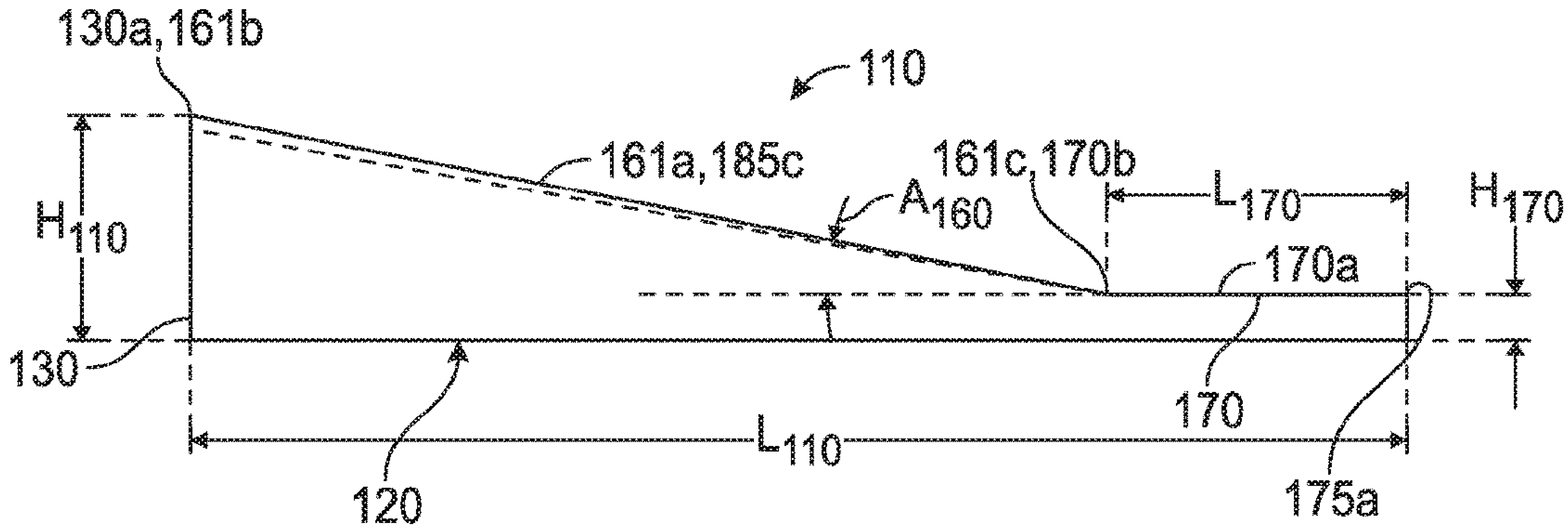

130a,161b
110
161a,185c
161c,170b
A_{160}
L_{170}
H_{170}
H_{110}
170a
130
170
L_{110}
120
175a

FIG. 4A

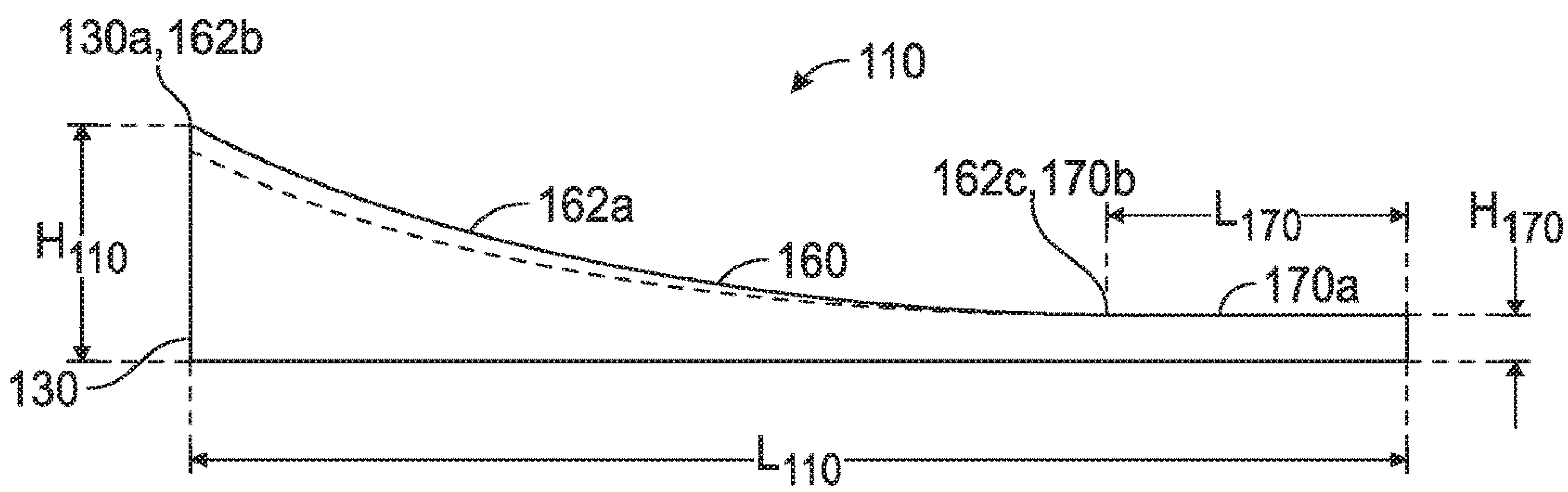

130a,162b
110
162a
160
162c,170b
L_{170}
H_{170}
H_{110}
170a
130
L_{110}

FIG. 4B

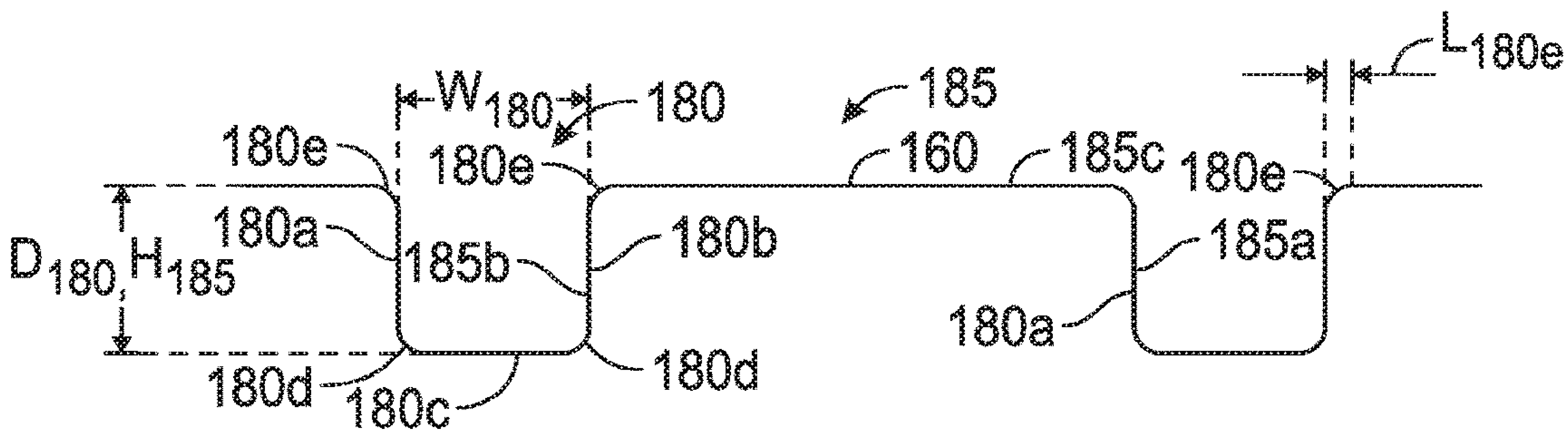


FIG. 5A

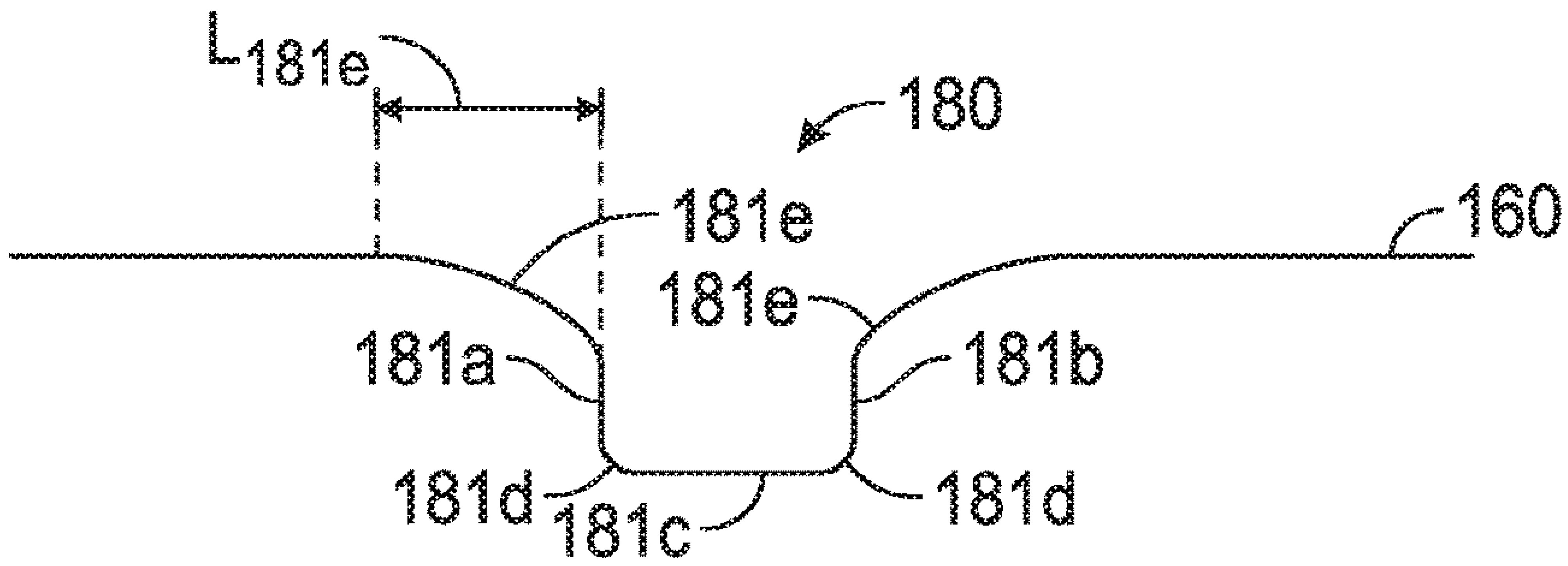


FIG. 5B

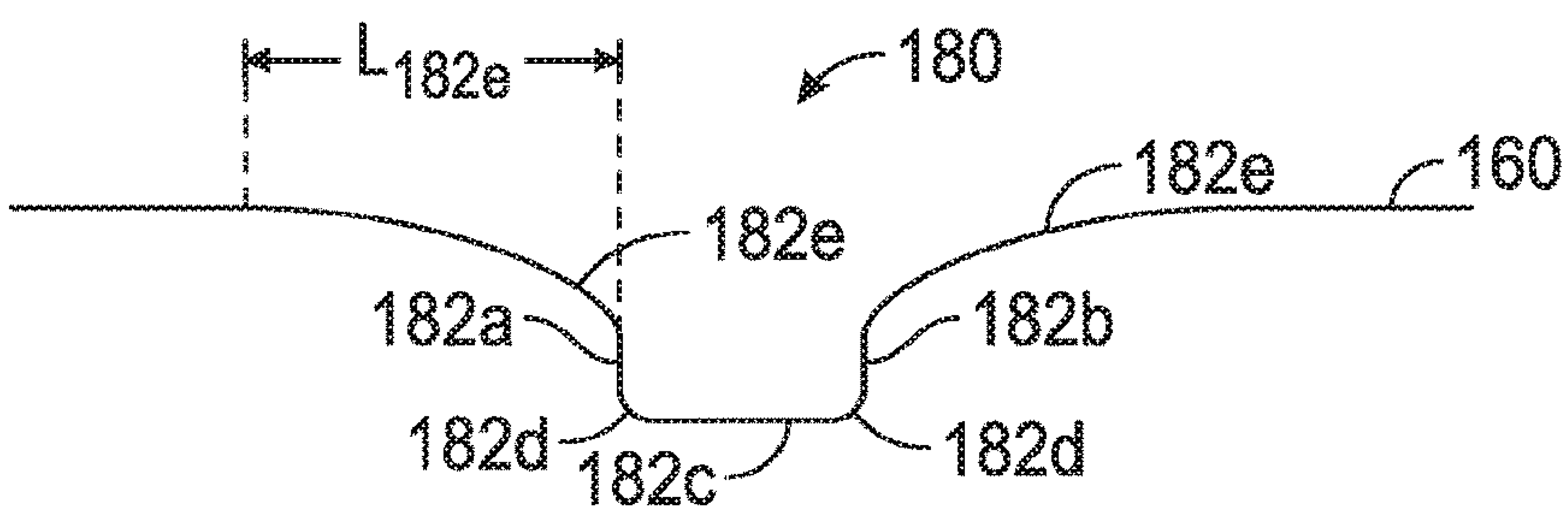


FIG. 5C

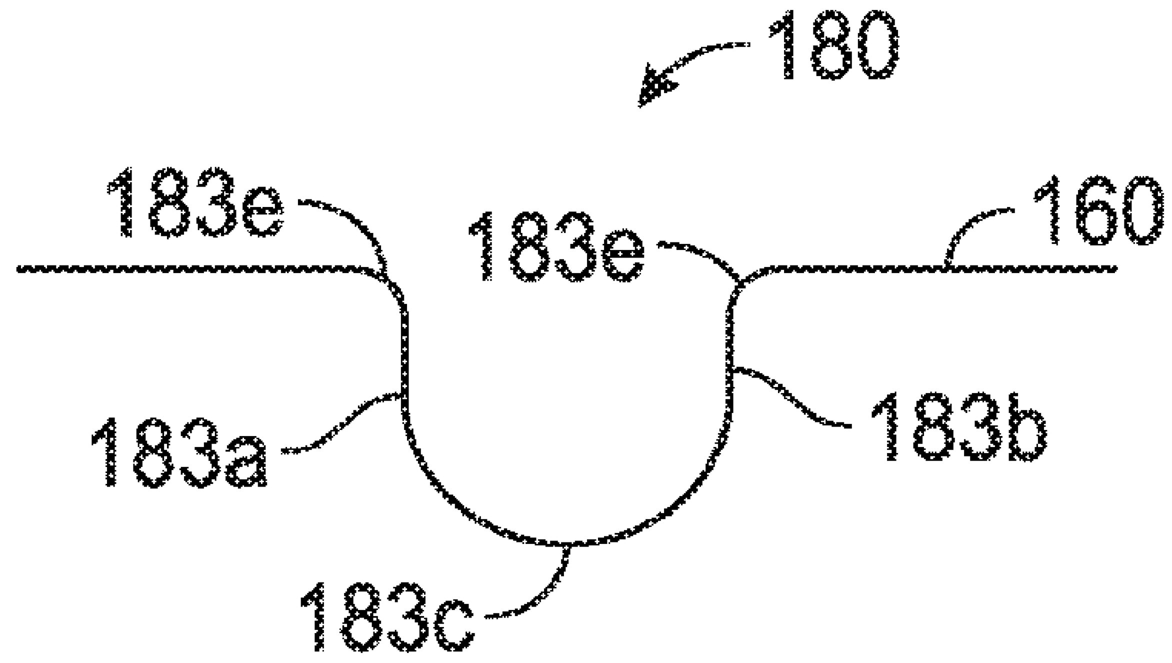


FIG. 5D

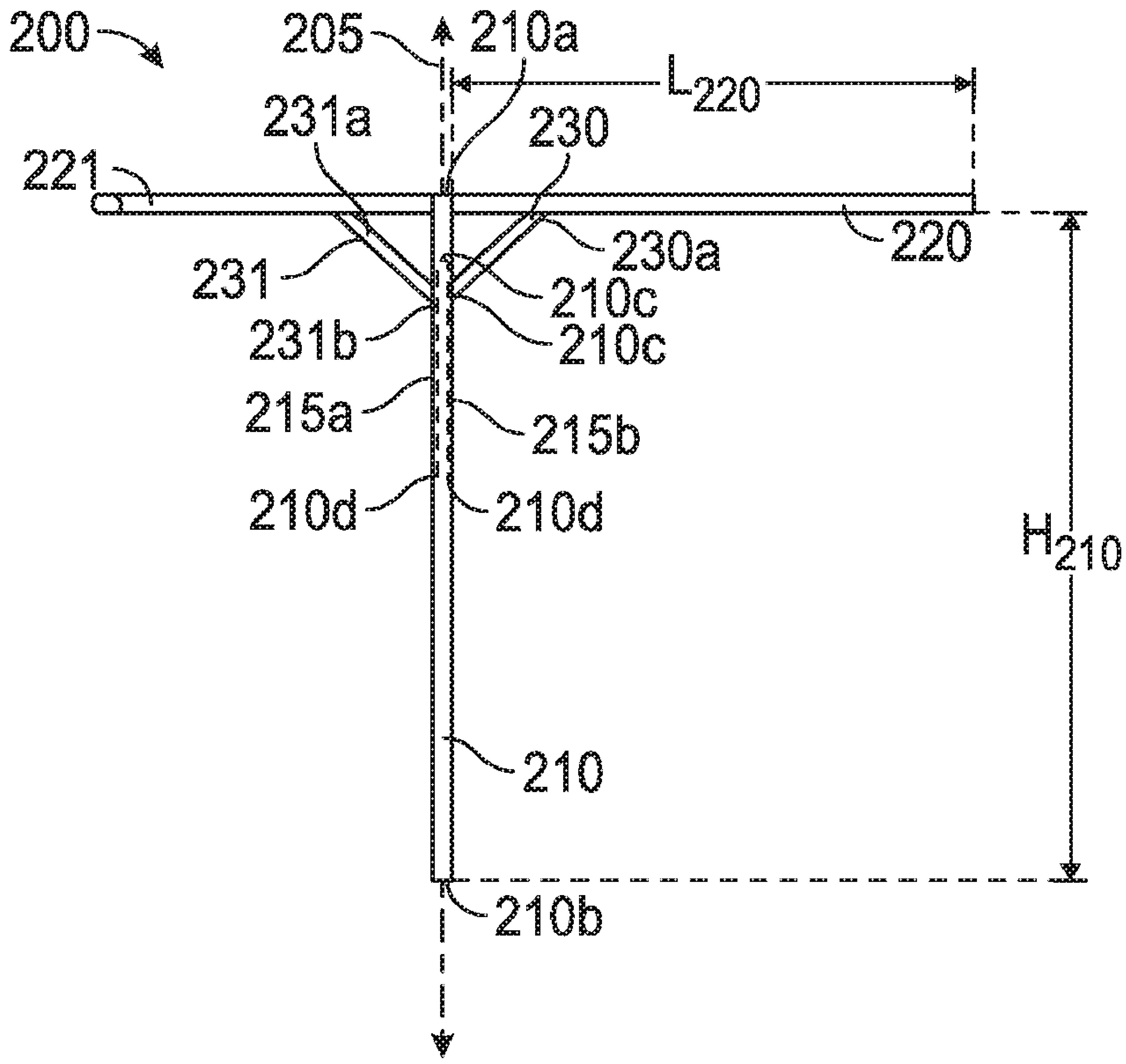

200
205
210a
L_{220}
231a
230
221
220
230a
231
210c
231b
210c
215a
215b
210d
210d
H_{210}
210
210b

FIG. 6A

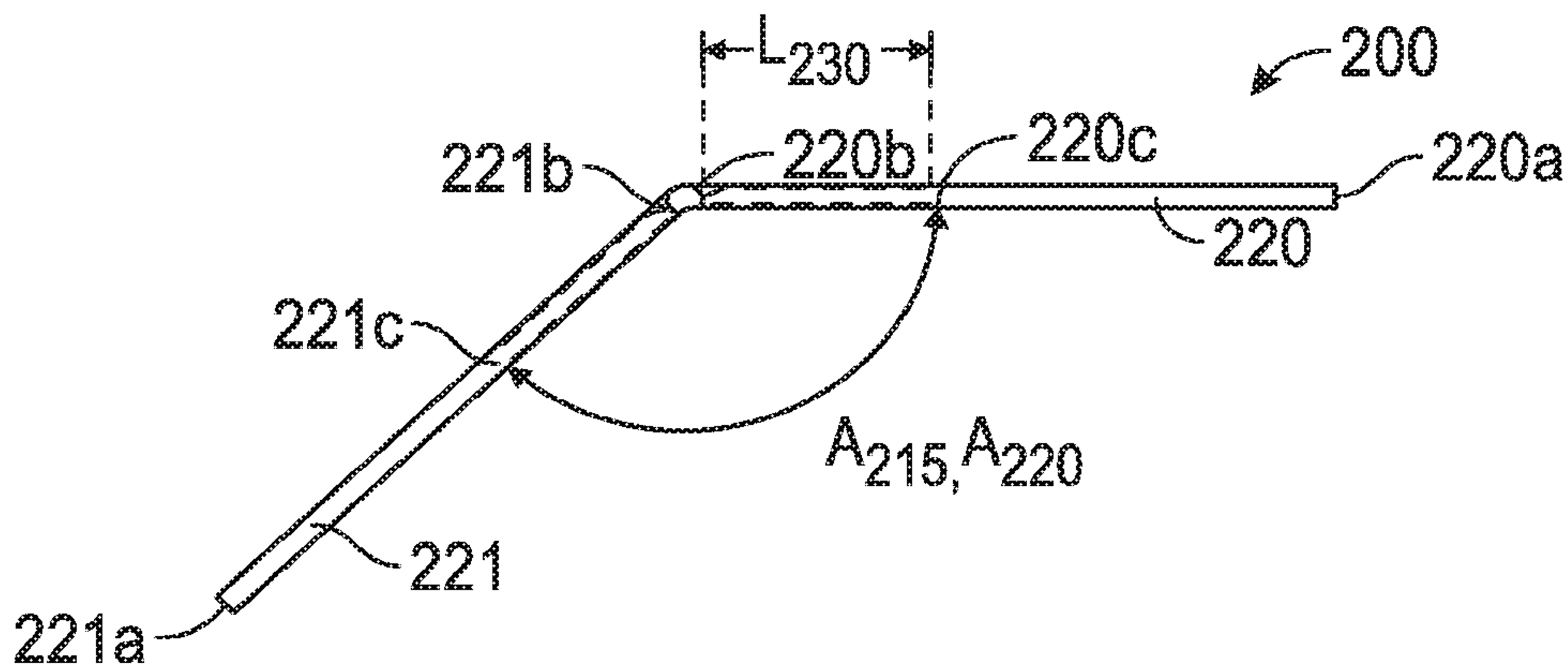
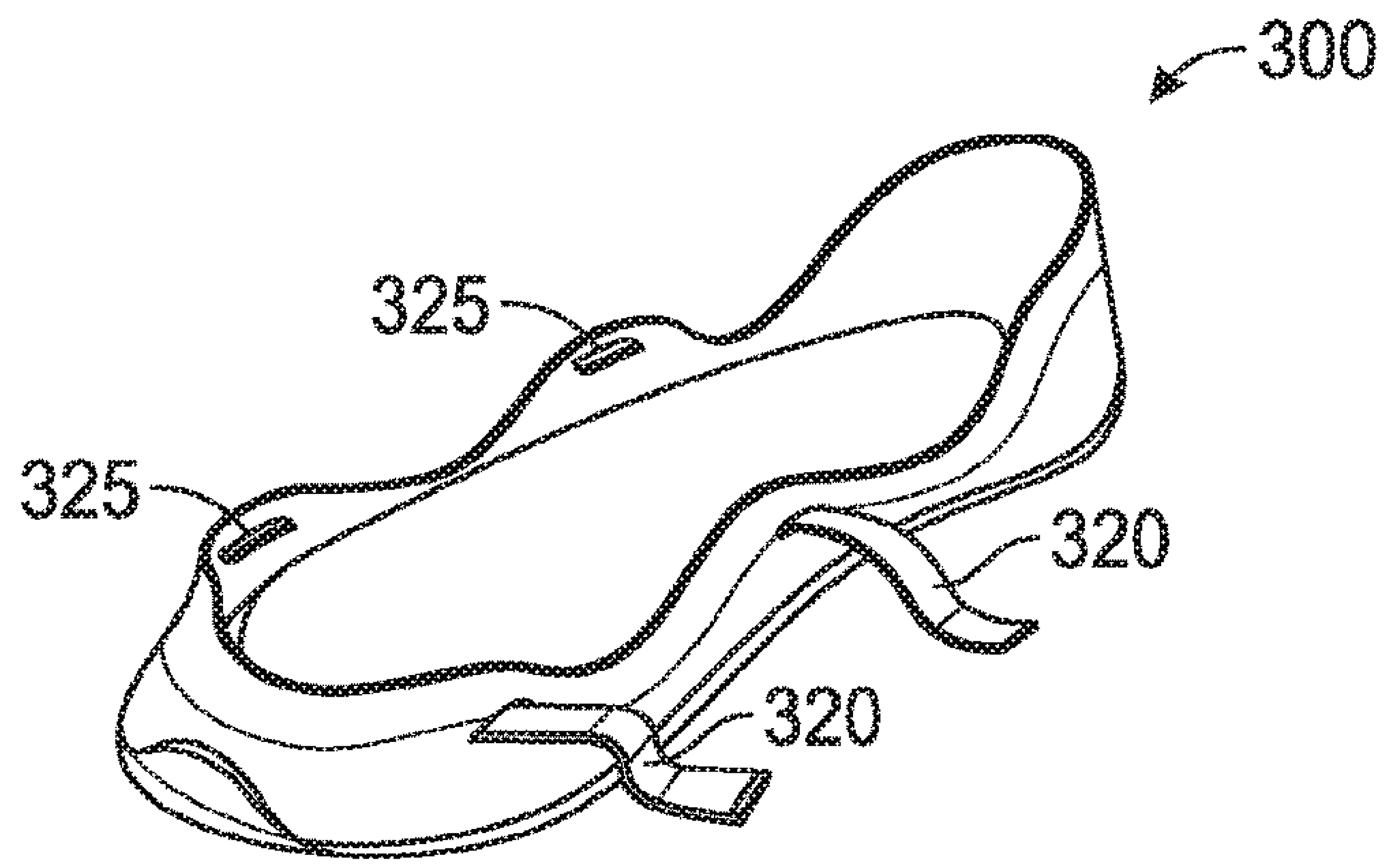

L_{230}
200
221b
220b
220c
220a
220
221c
A_{215}, A_{220}
221
221a

FIG. 6B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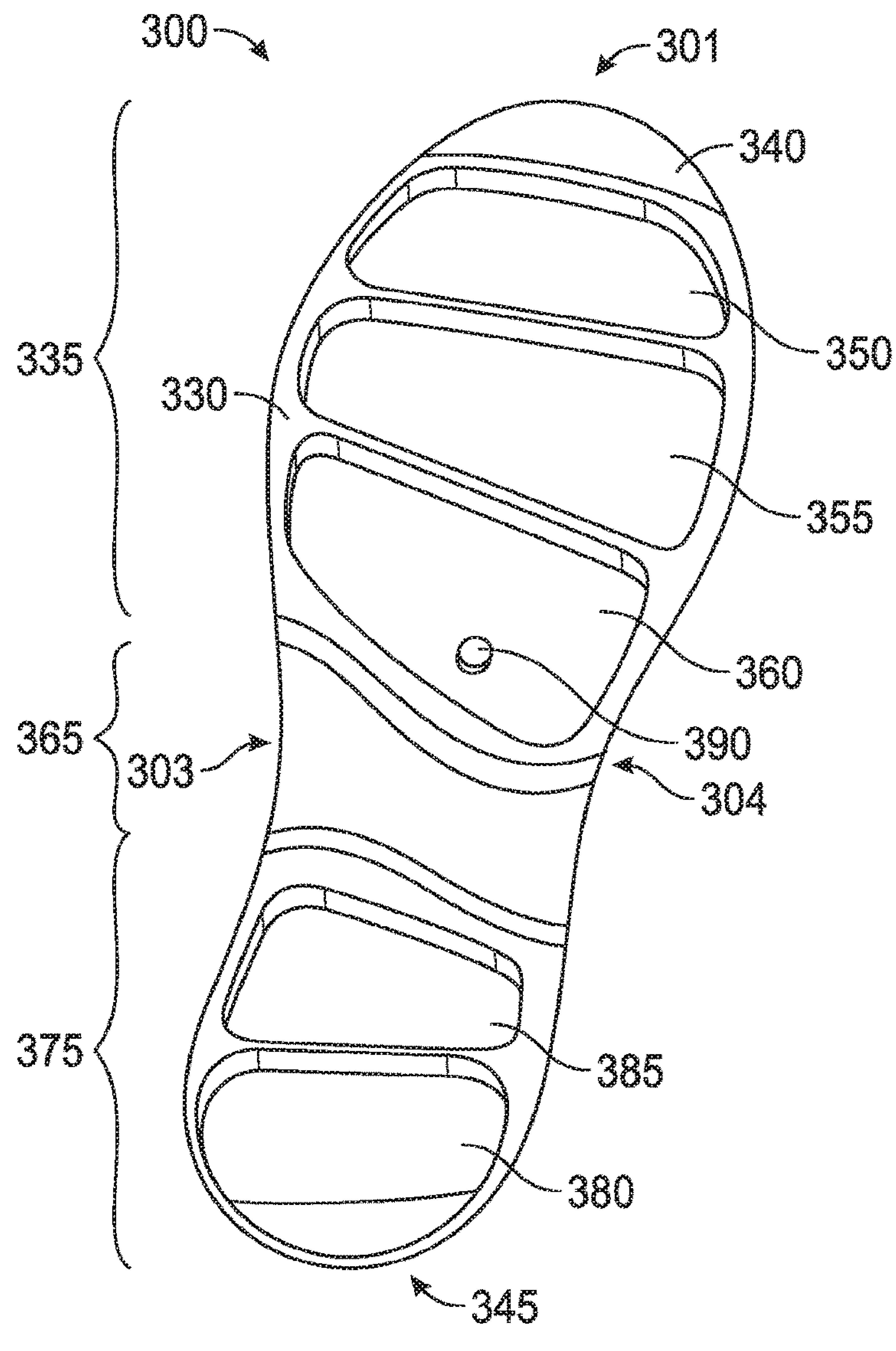
325
325
320
320

FIG. 7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301
340
350
335
330
355
360
390
365
303
304
375
385
380
345

FIG. 8

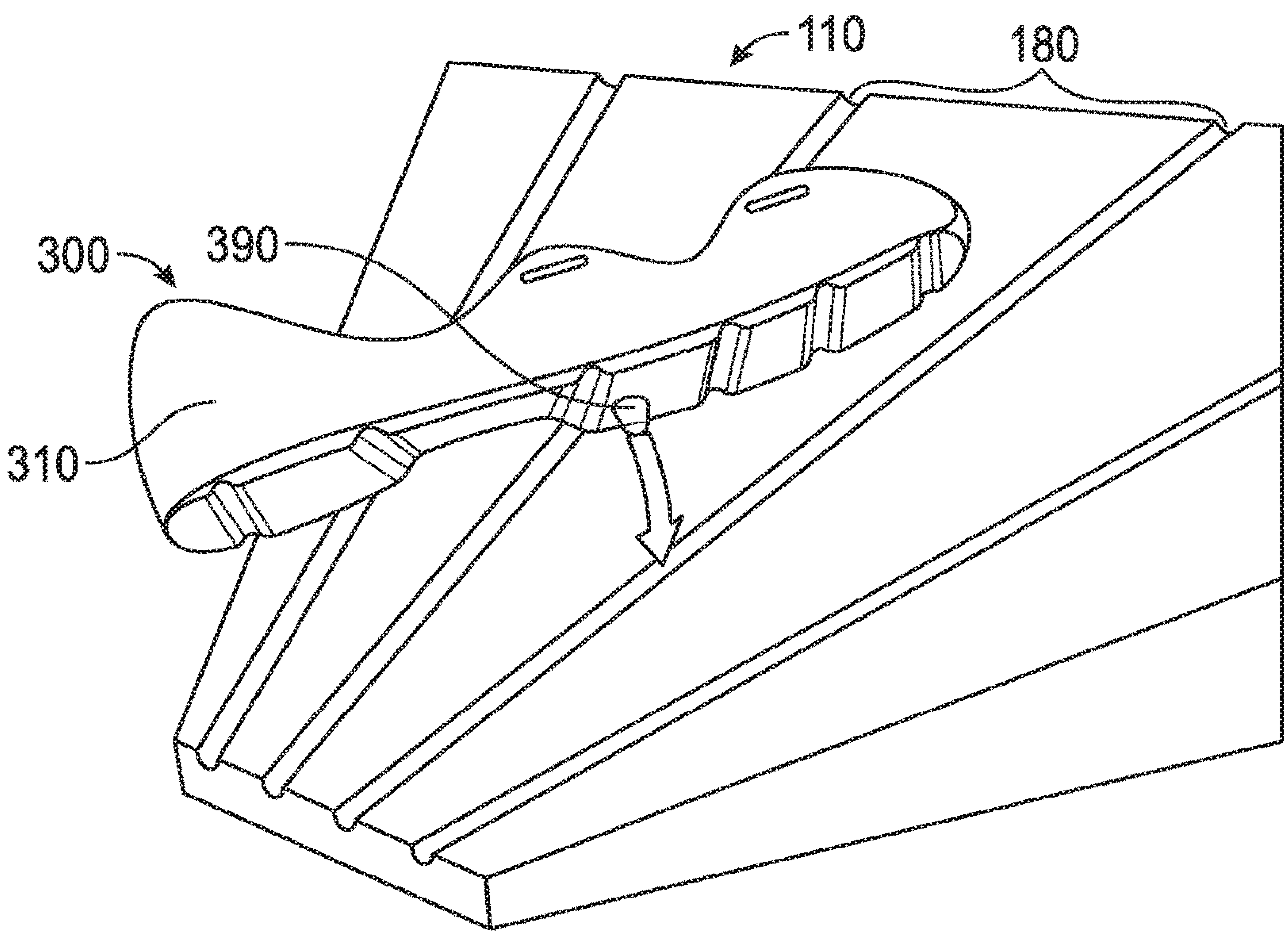


FIG. 9

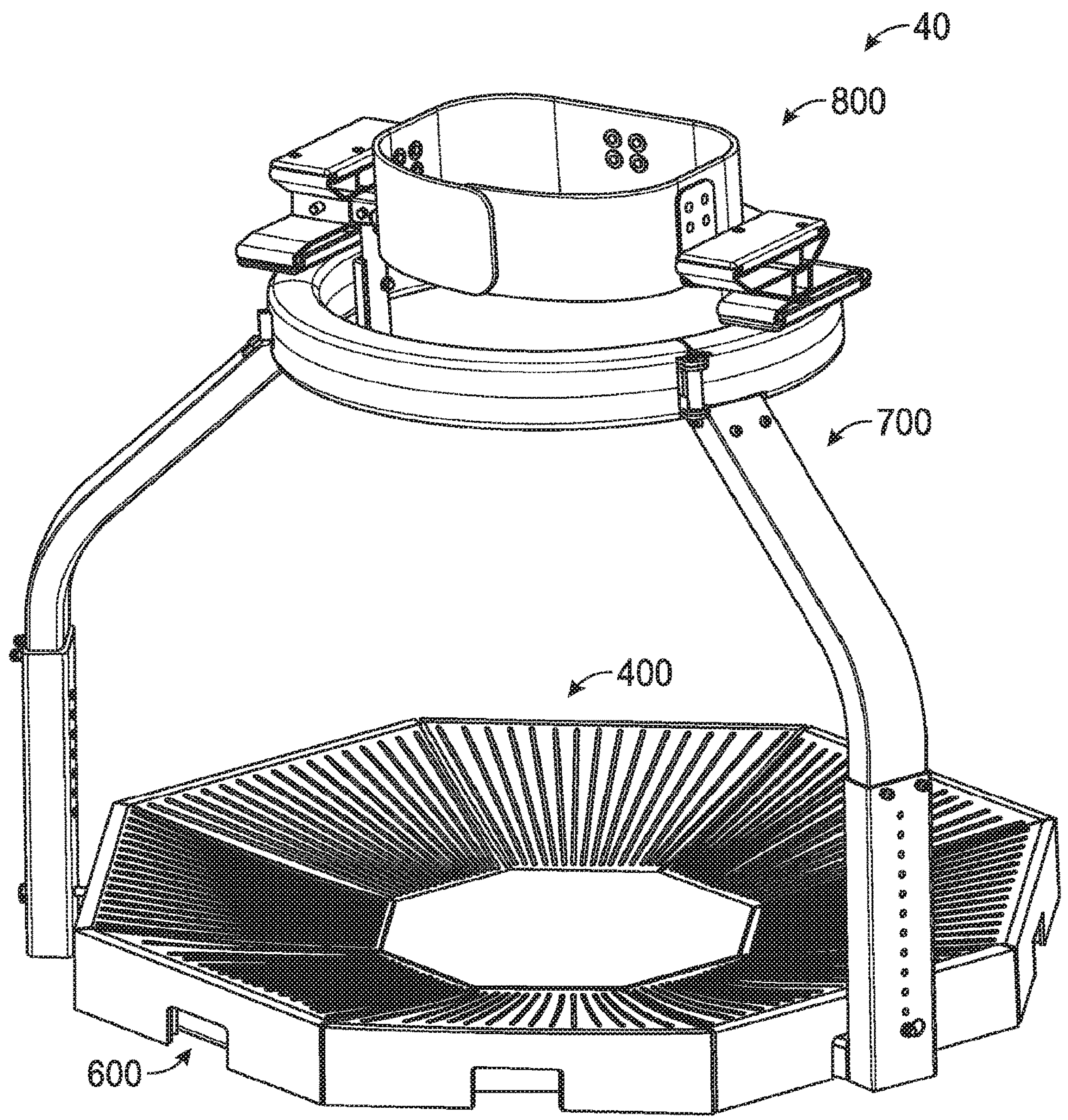
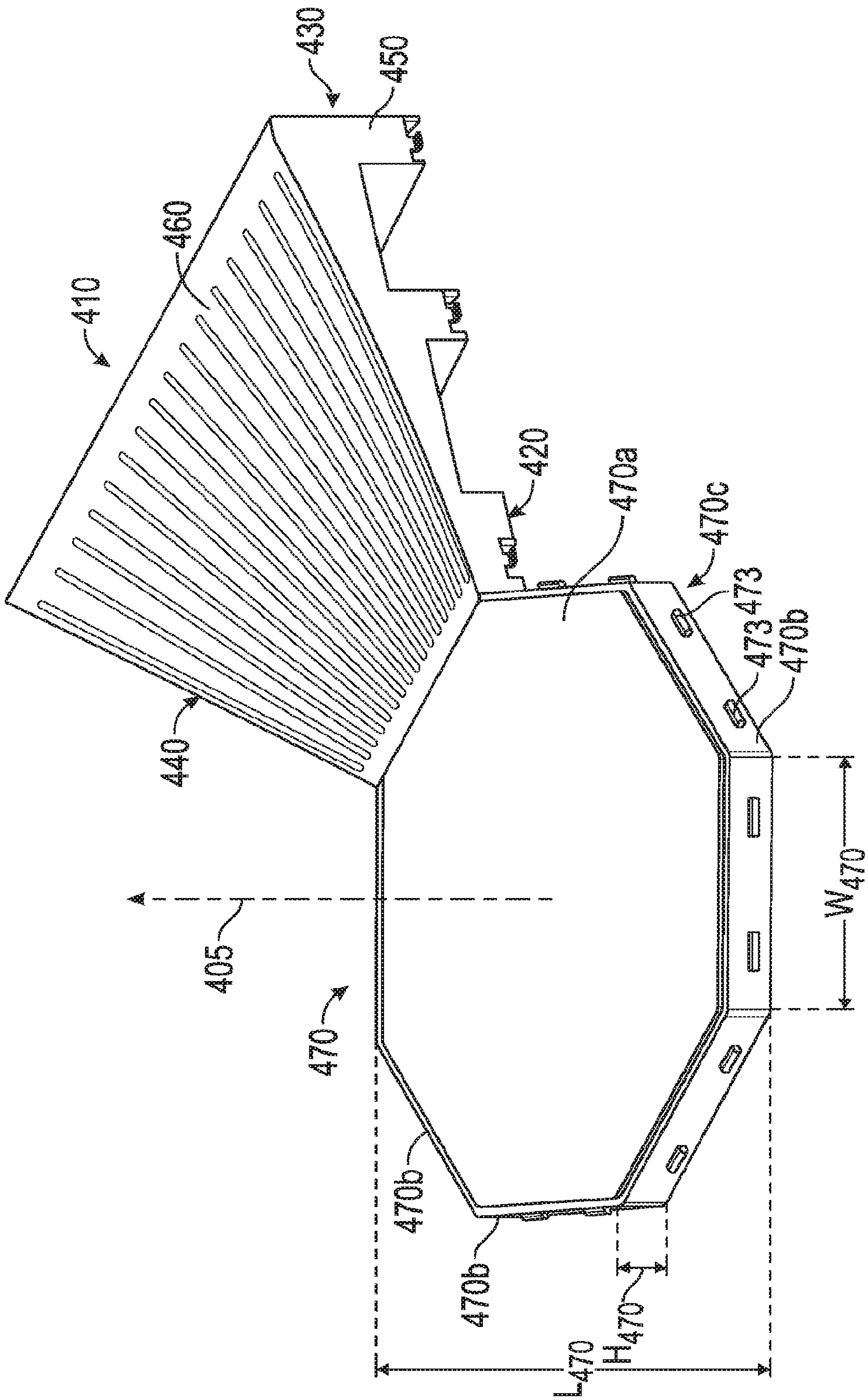


FIG. 10



430
450
460
410
420
470a
470c
473
473
470b
440
405
470
W470
470b
470b
H470
L470

FIG. 11

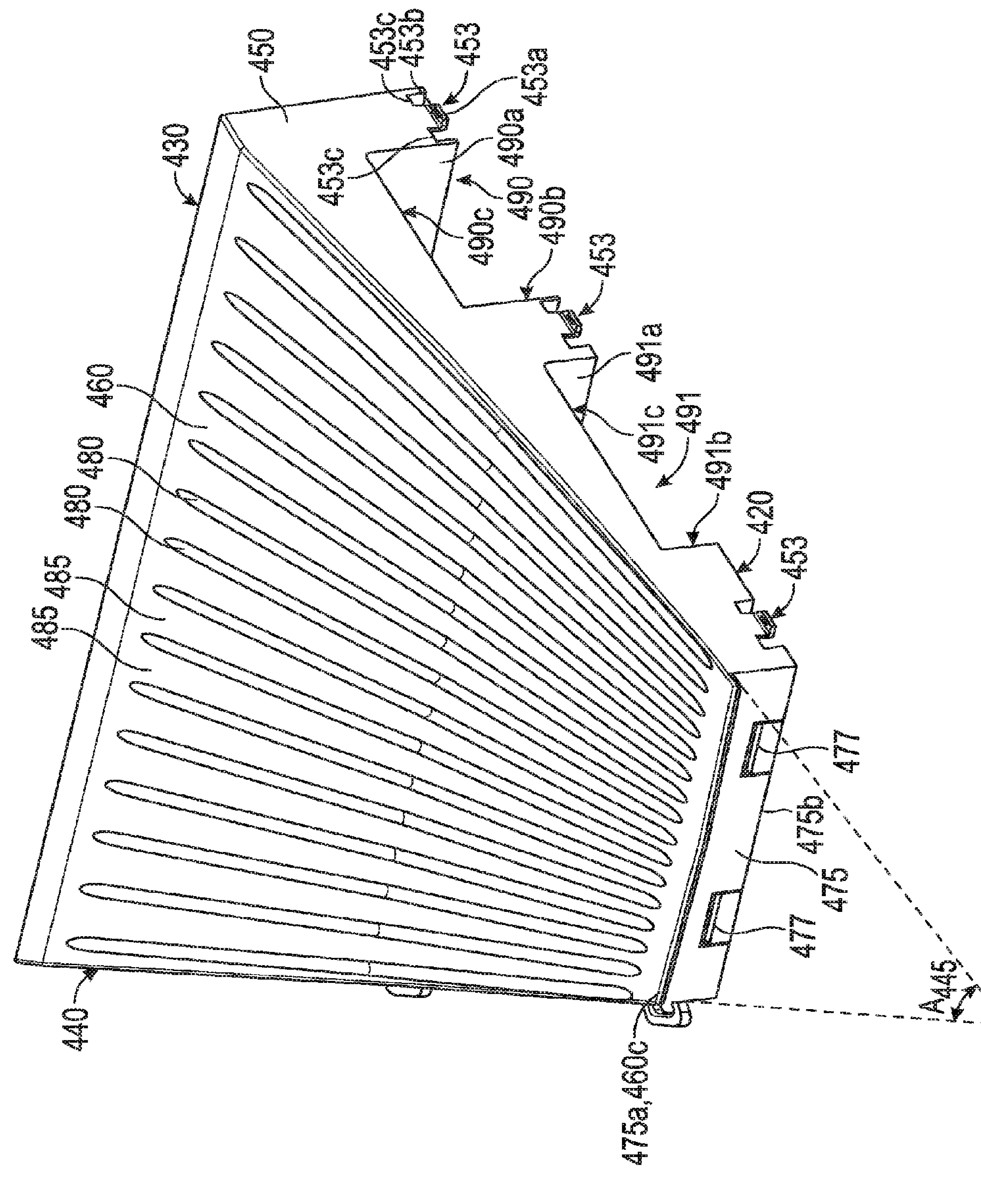
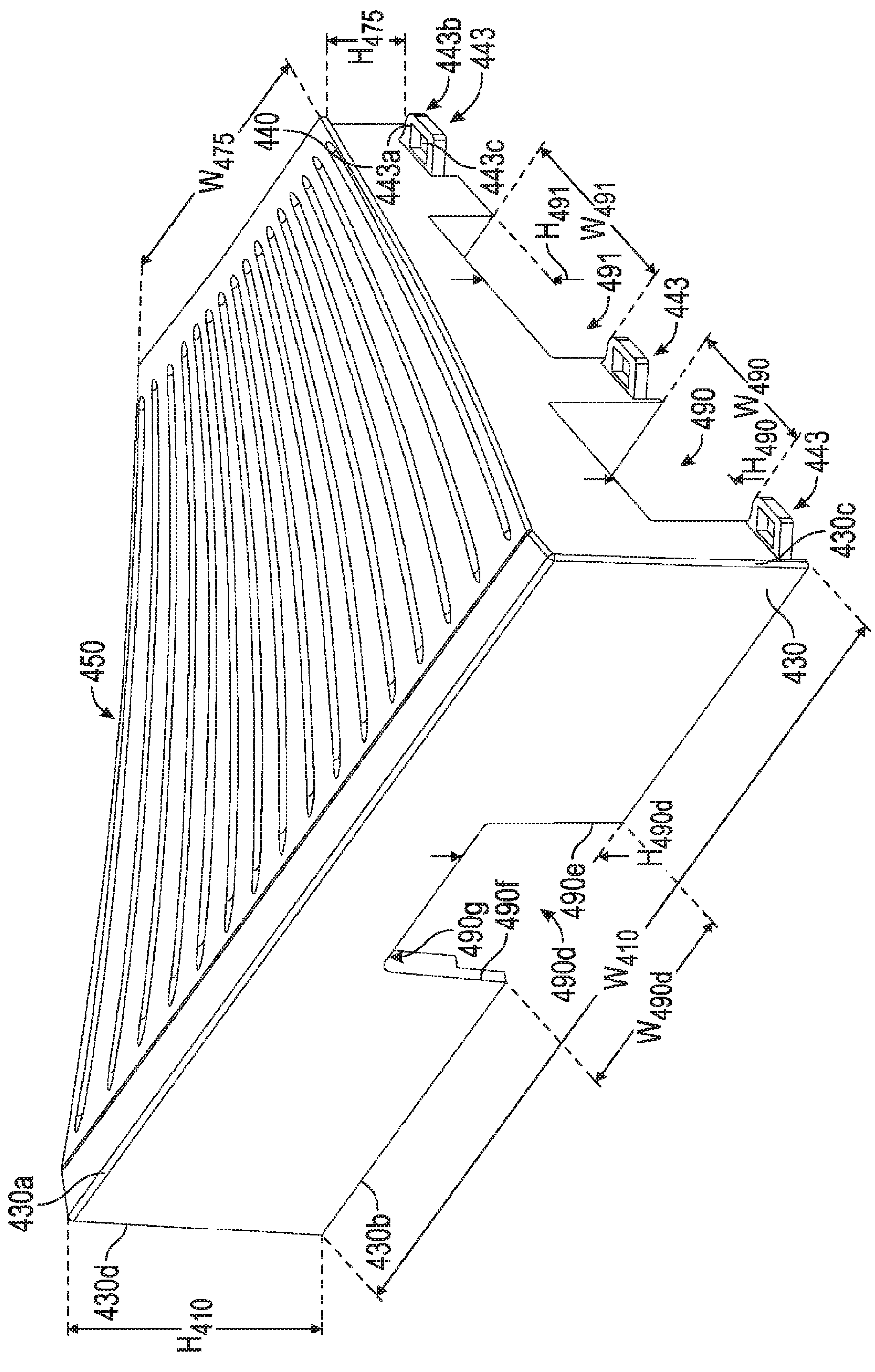

450
453c
453b
453
453a
430
453c
490a
490
490c
490b
453
491a
491
491c
491b
460
480
480
485
485
485
420
453
477
475b
475
477
440
A
445
475a,460c

FIG. 12A



450
440
443
443a
443b
443c
H_{475}
W_{475}
H_{491}
W_{491}
491
490
H_{490}
W_{490}
430
430a
430b
430c
430d
H_{410}
W_{410}
490d
490e
490f
490g
H_{490d}
W_{490d}

FIG. 12B

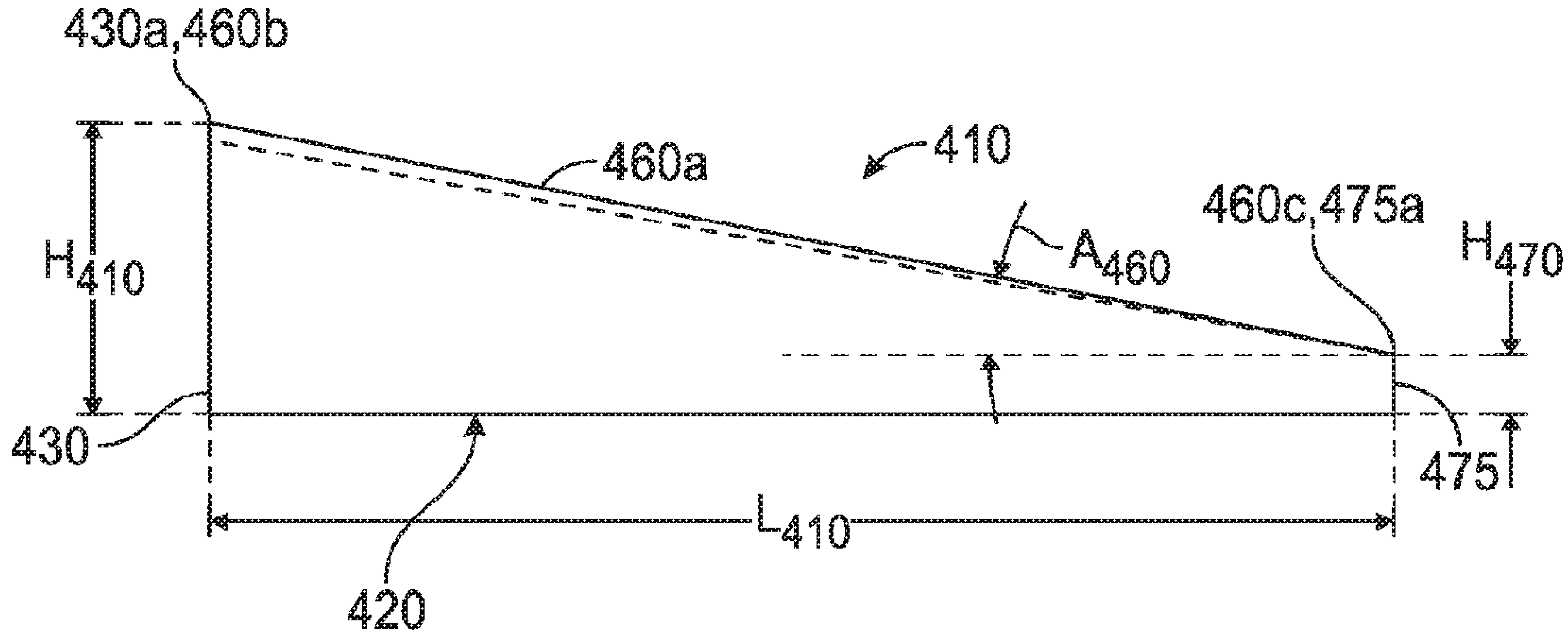


FIG. 13A

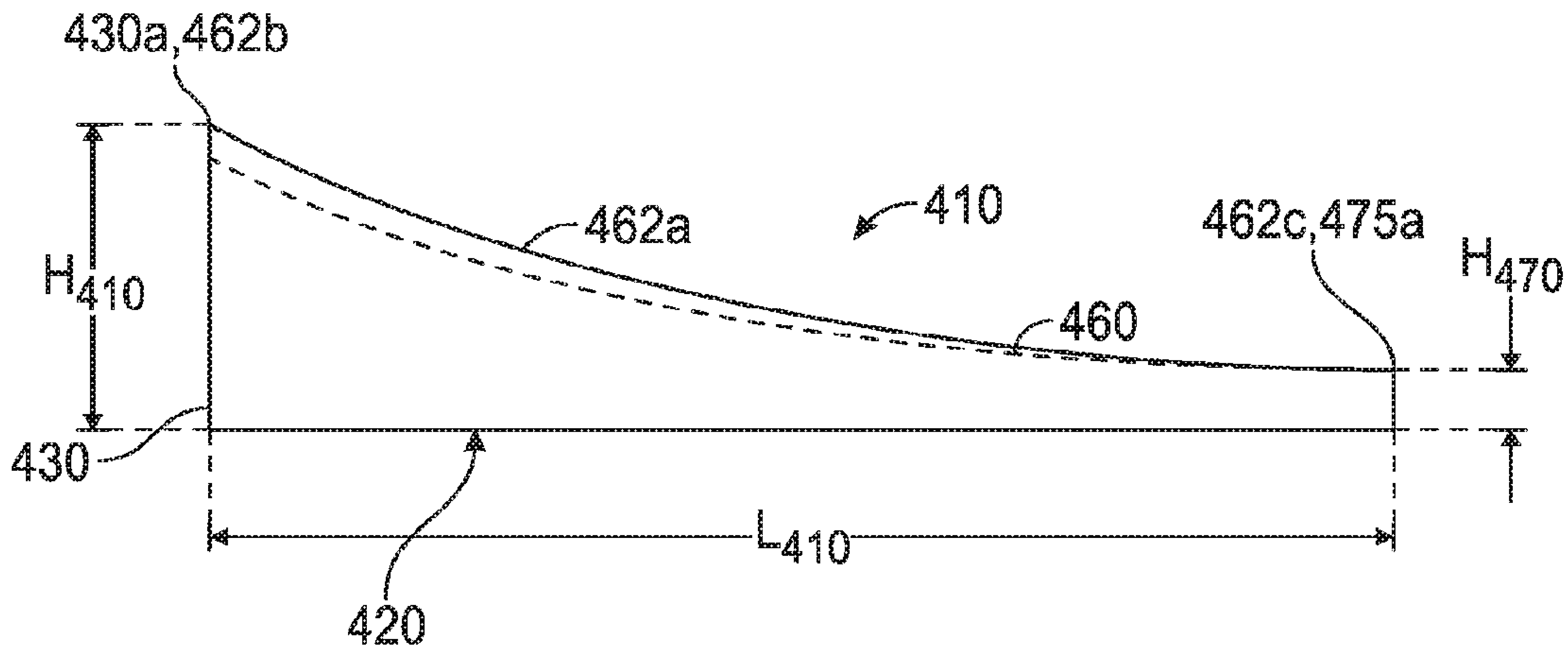


FIG. 13B

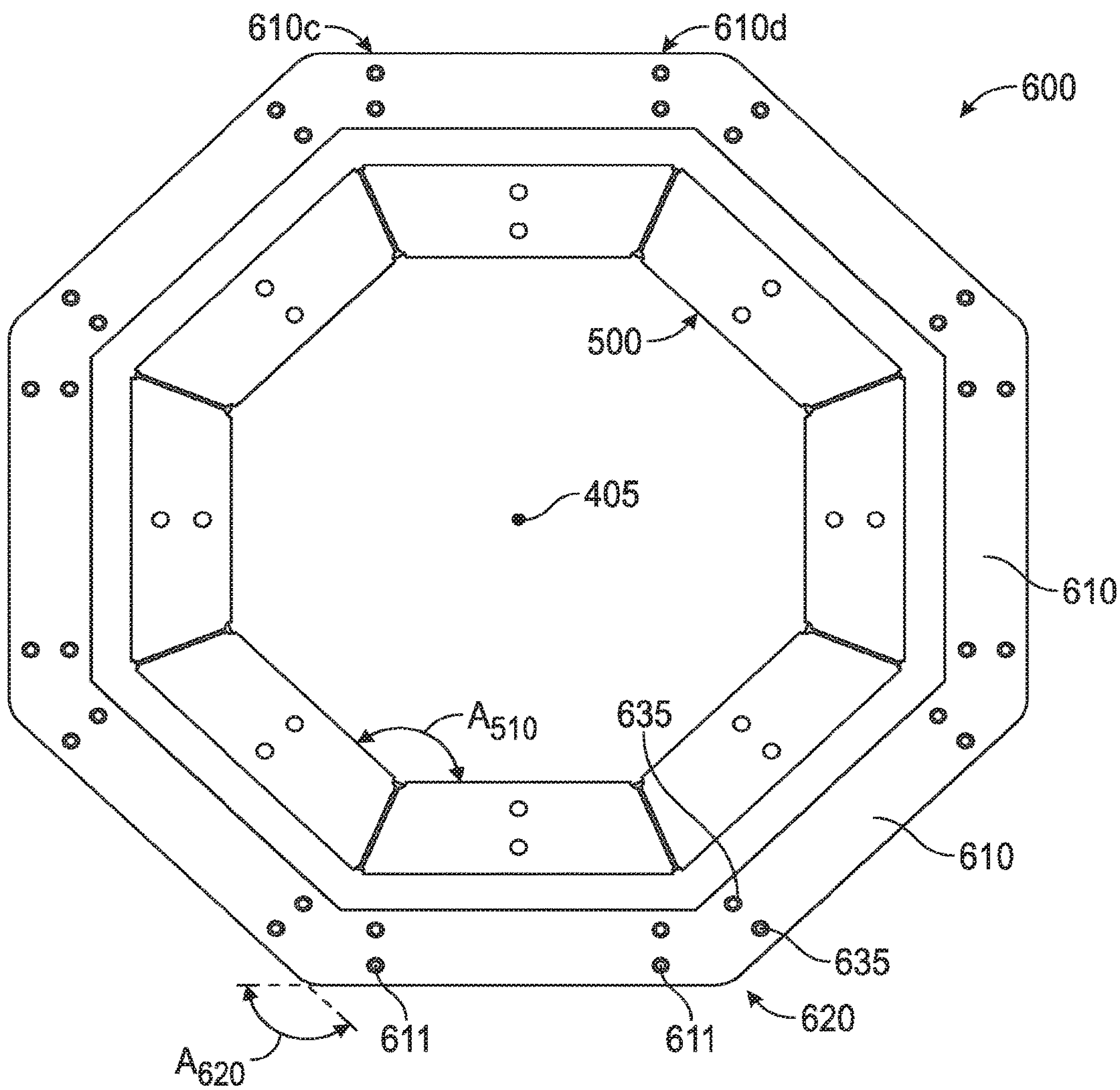


FIG. 14

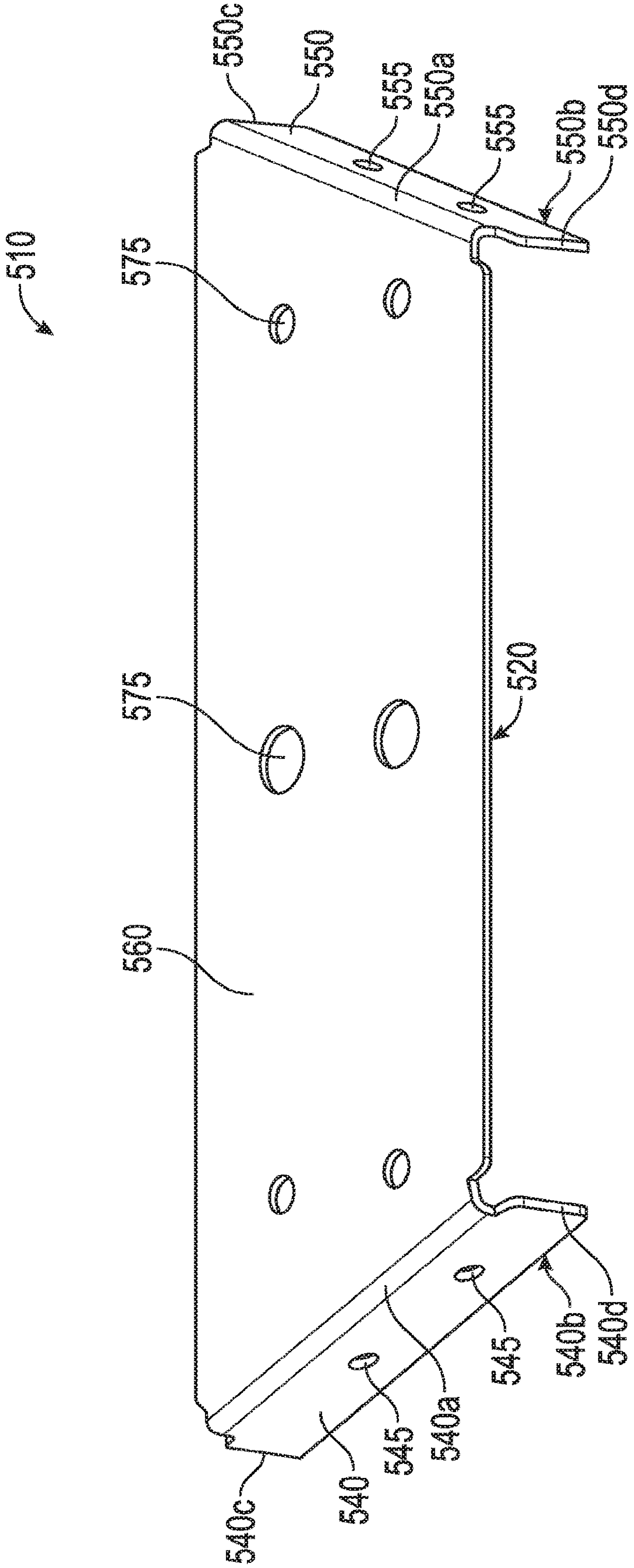

550c
550
555
550a
555
550b
550d
510
575
575
520
560
540c
540
545
540a
545
540b
540d

FIG. 15

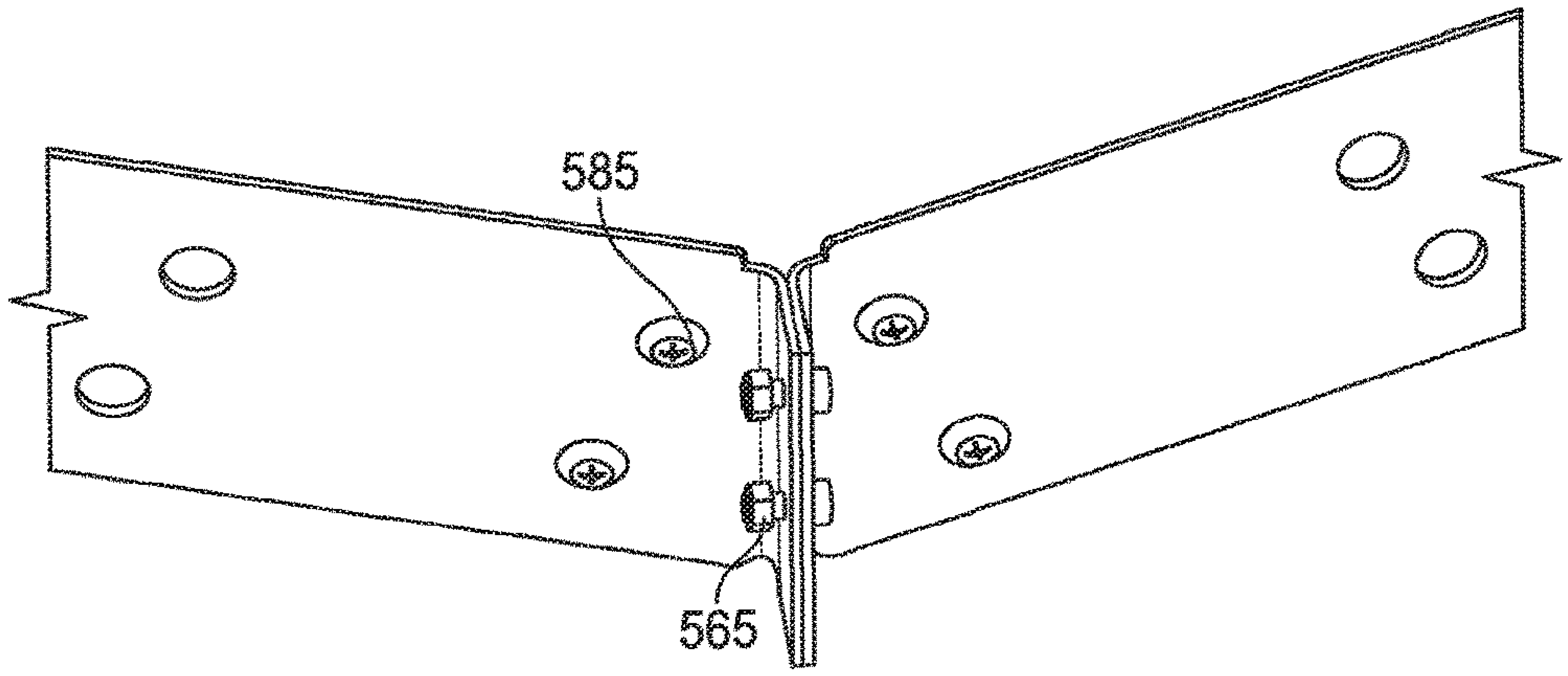


FIG. 16

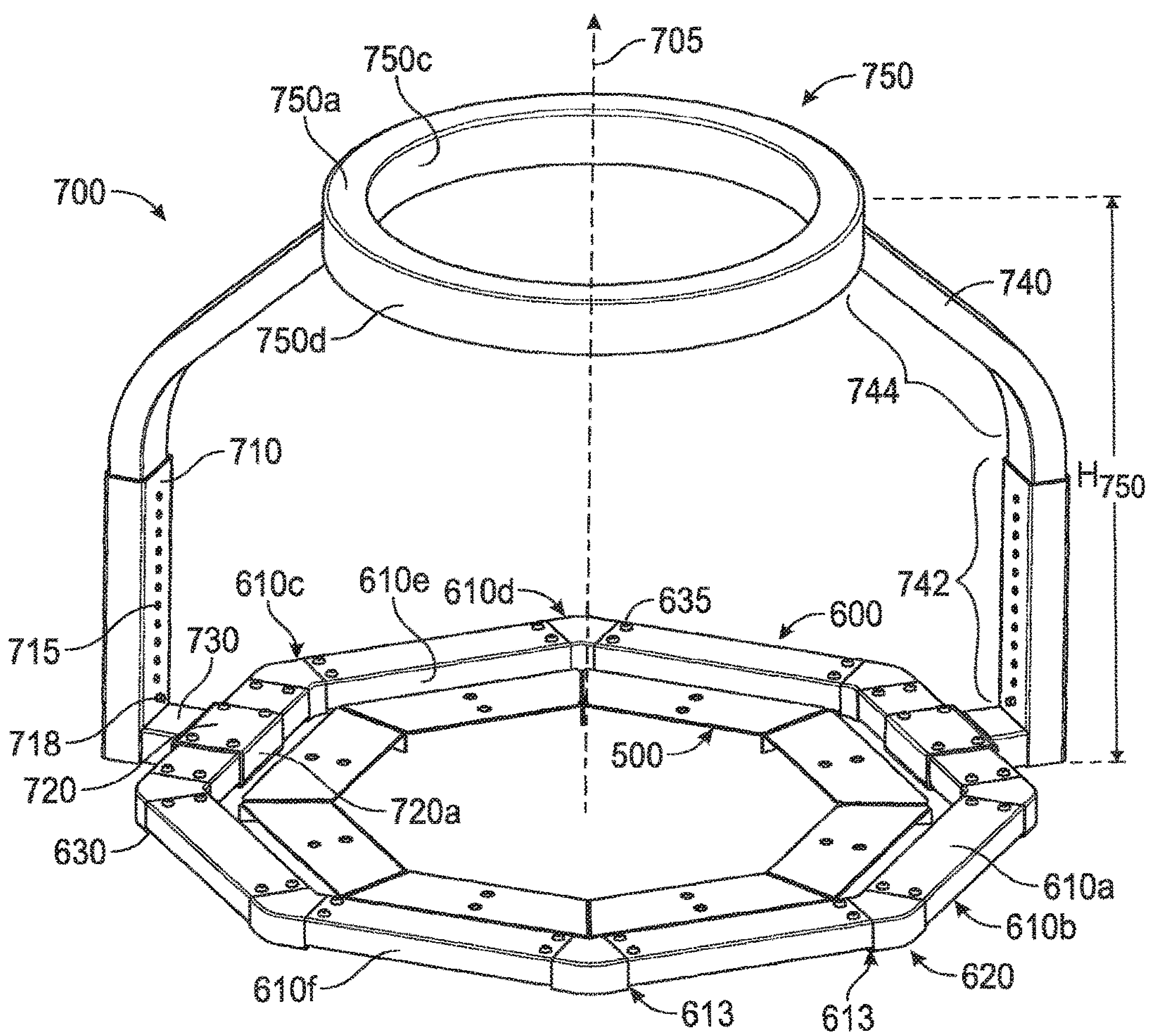


FIG. 17A

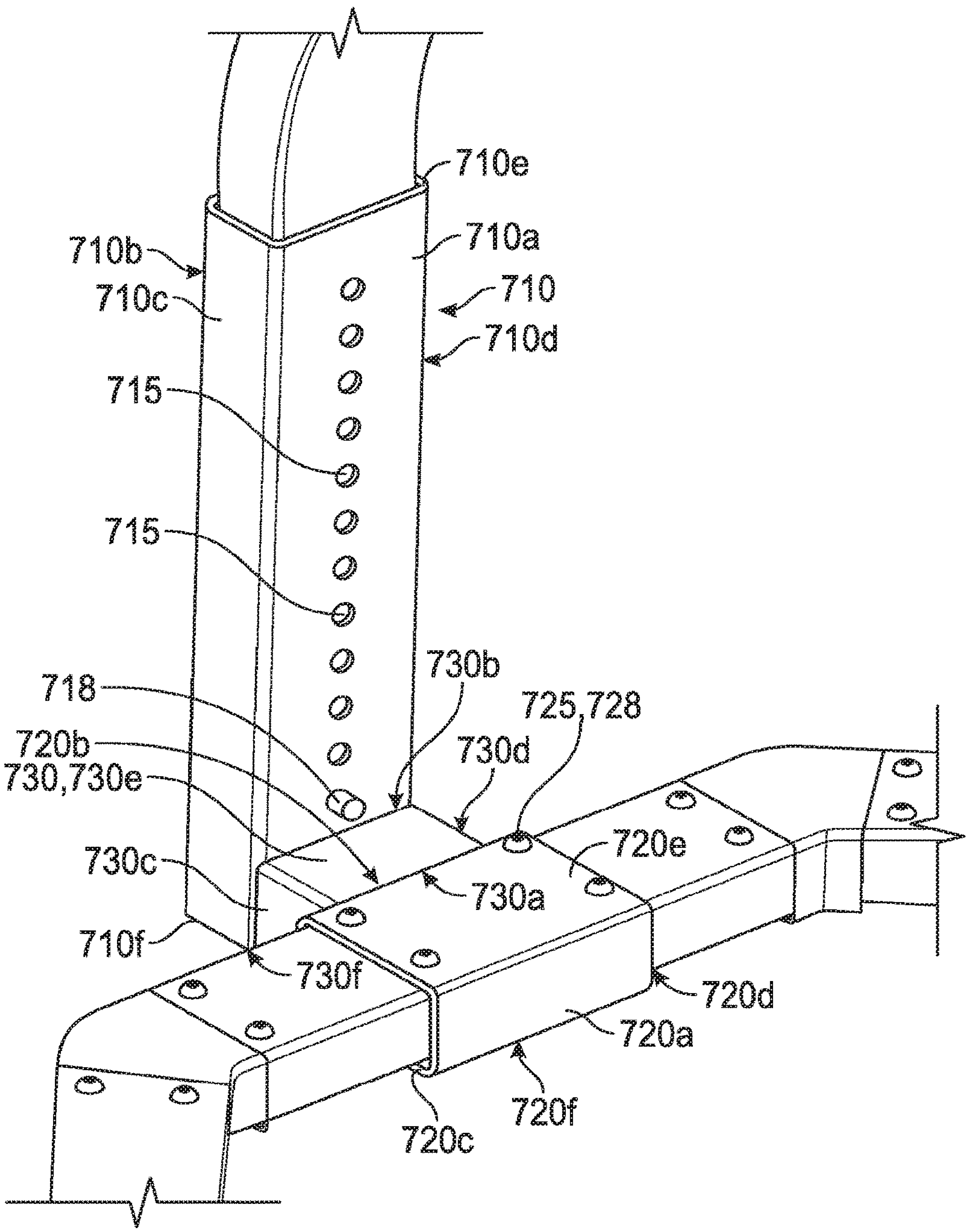

710e
710a
710b
710c
710
710d
715
715
730b
718
725,728
720b
730d
730,730e
720e
730c
730a
710f
730f
720d
720a
720f
720c

FIG. 17B

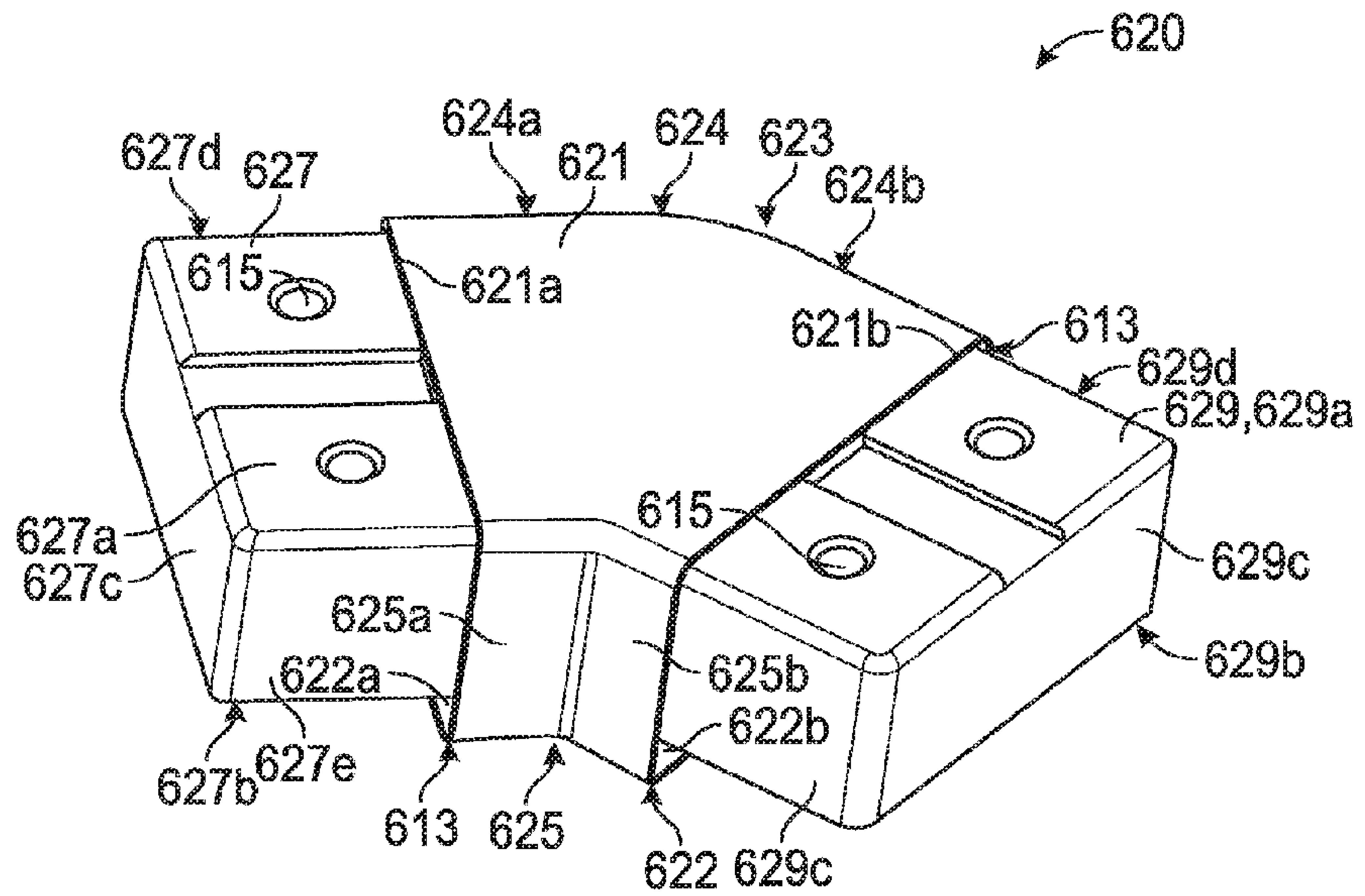

620
627d
627
624a
621
624
623
624b
615
621a
621b
613
629d
629,629a
627a
627c
615
629c
625a
625b
622a
622b
629b
627b
627e
613
625
622
629c

FIG. 18

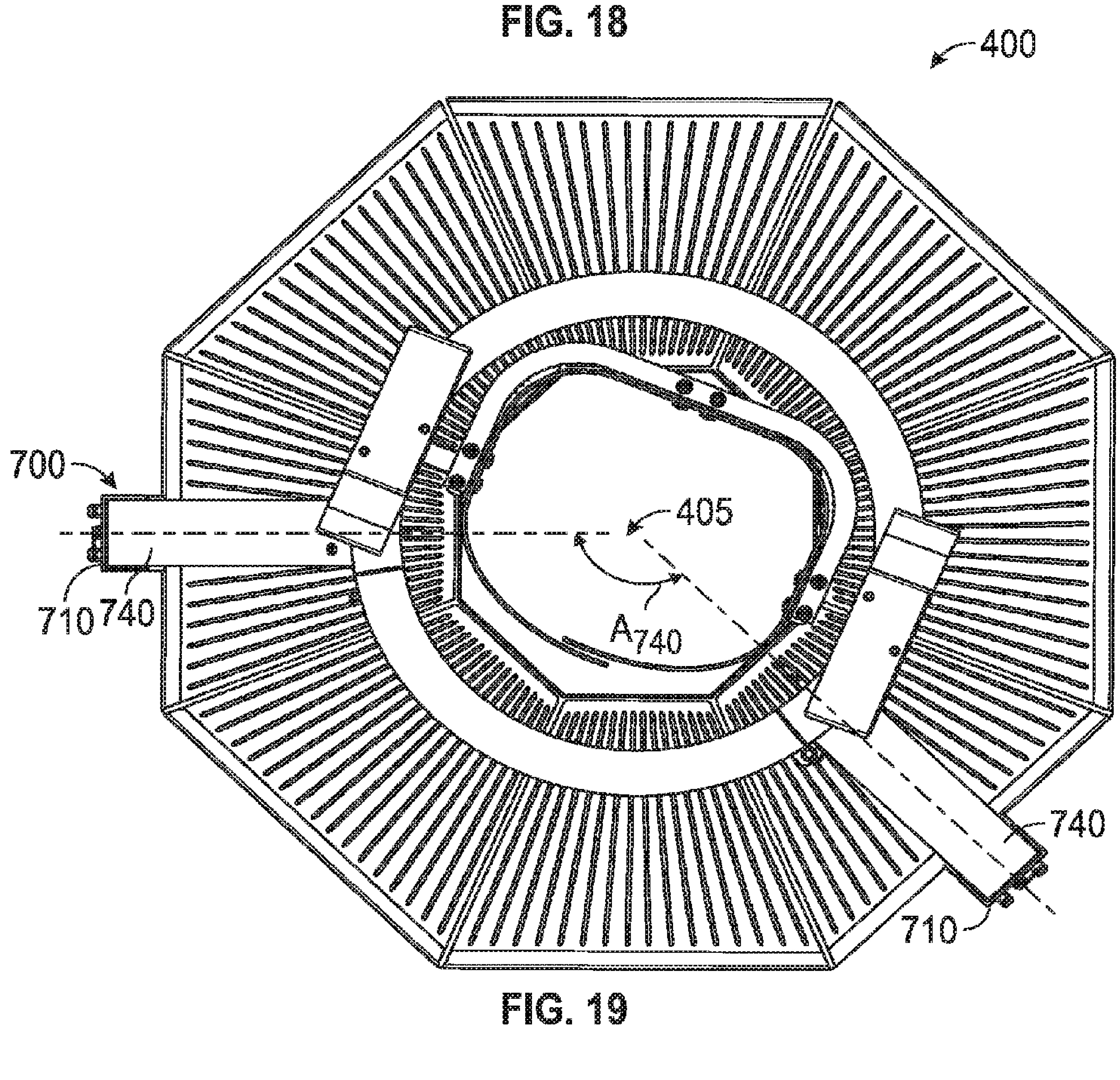

400
700
405
710
740
A_{740}
740
710

FIG. 19

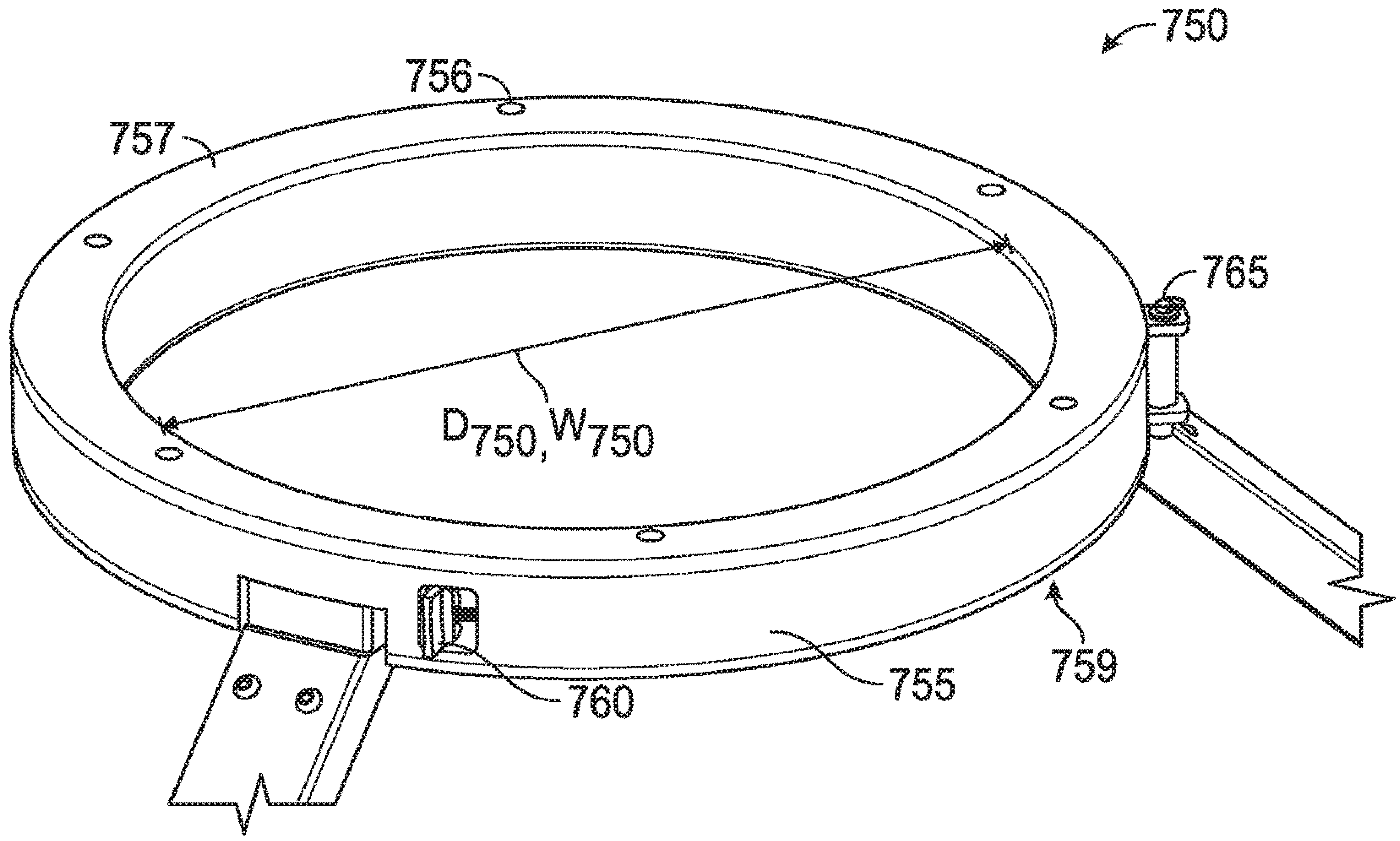

750
756
757
765
D_{750},W_{750}
760
755
759

FIG. 20

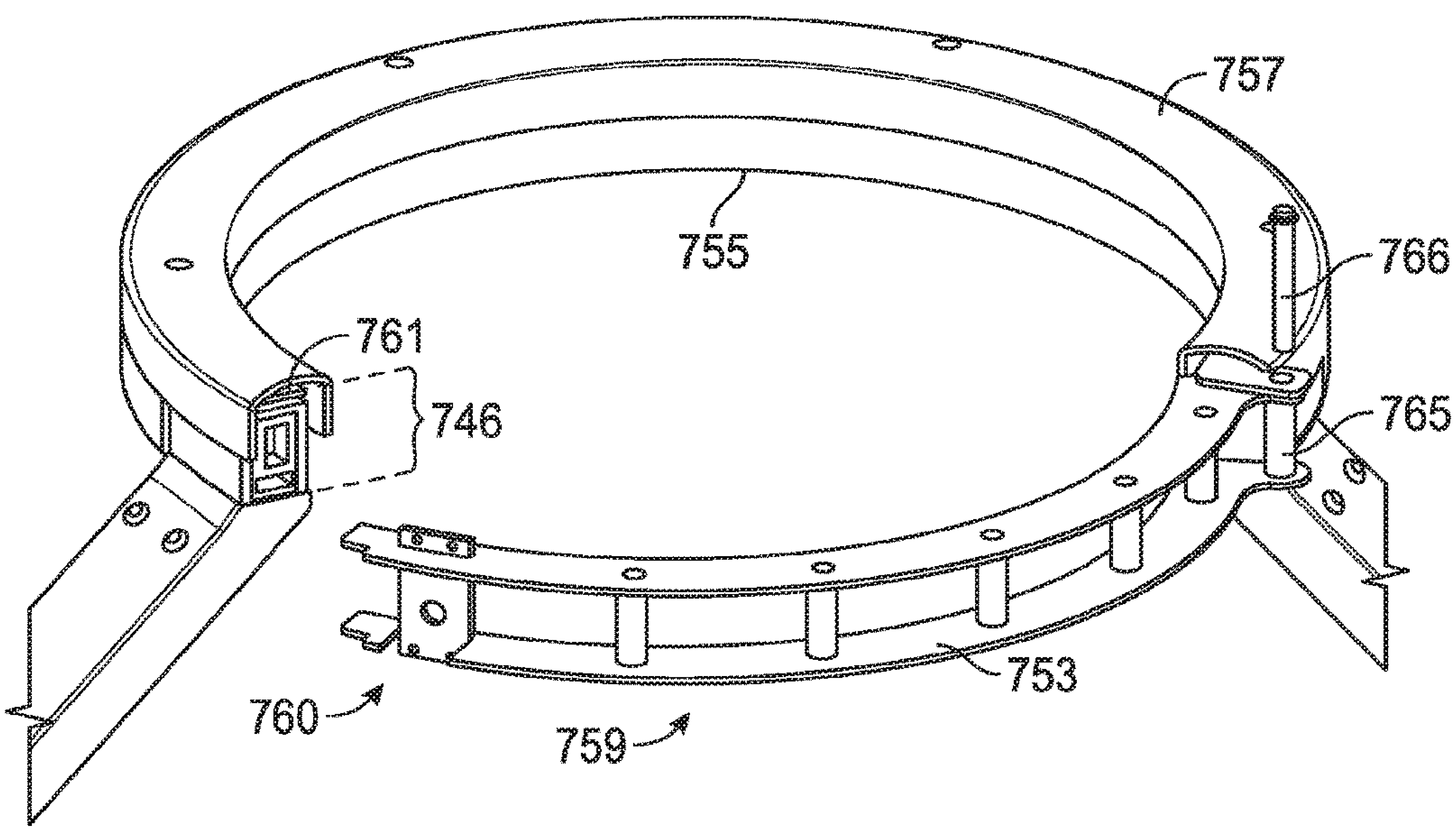

757
755
766
761
746
765
753
760
759

FIG. 21

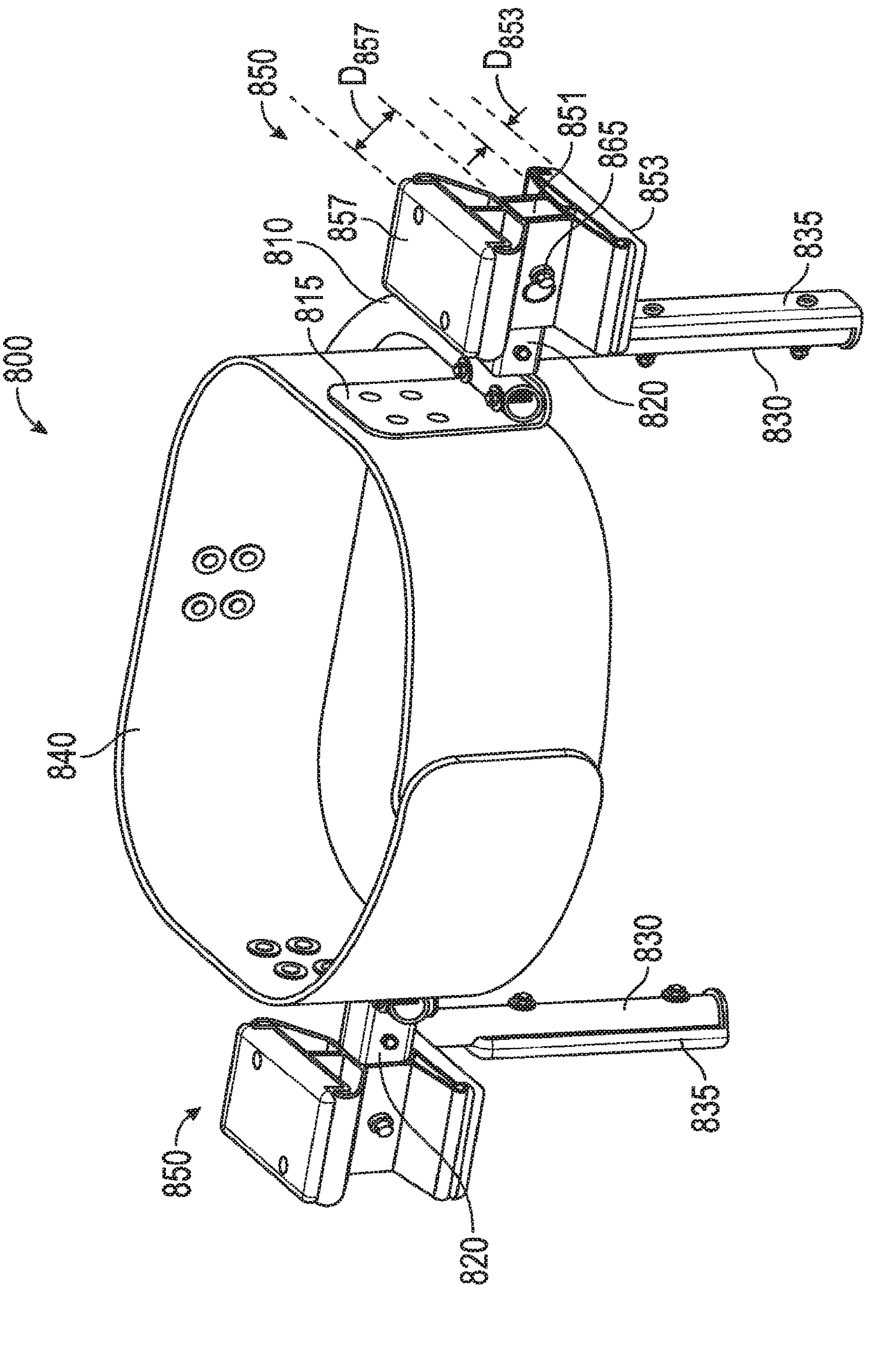

800
850
D_{857}
D_{853}
851
865
853
810
857
815
835
820
830
840
850
830
835
820

FIG. 22

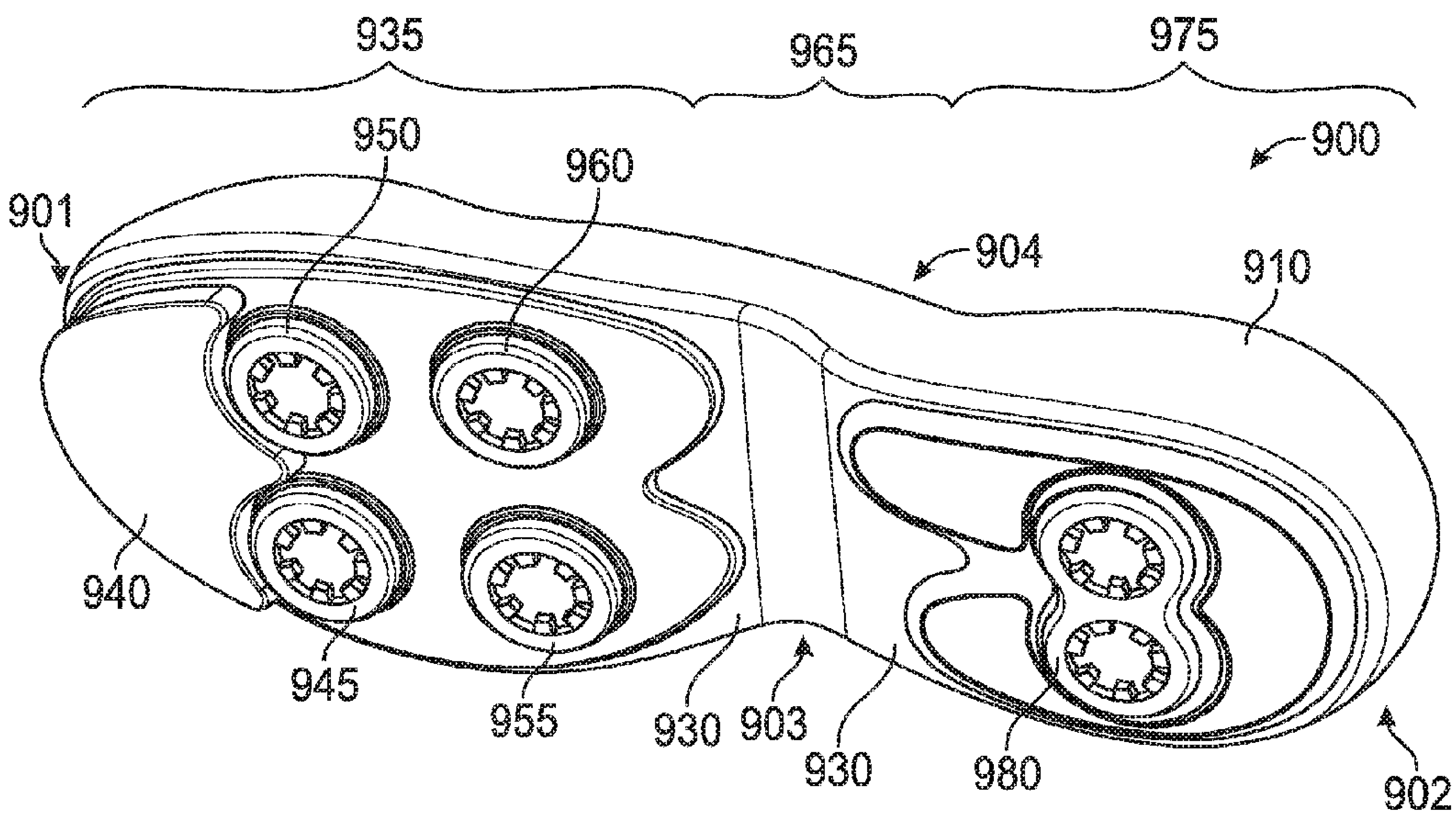

935
965
975
900
950
960
901
904
910
940
945
955
930
903
930
980
902

FIG. 23

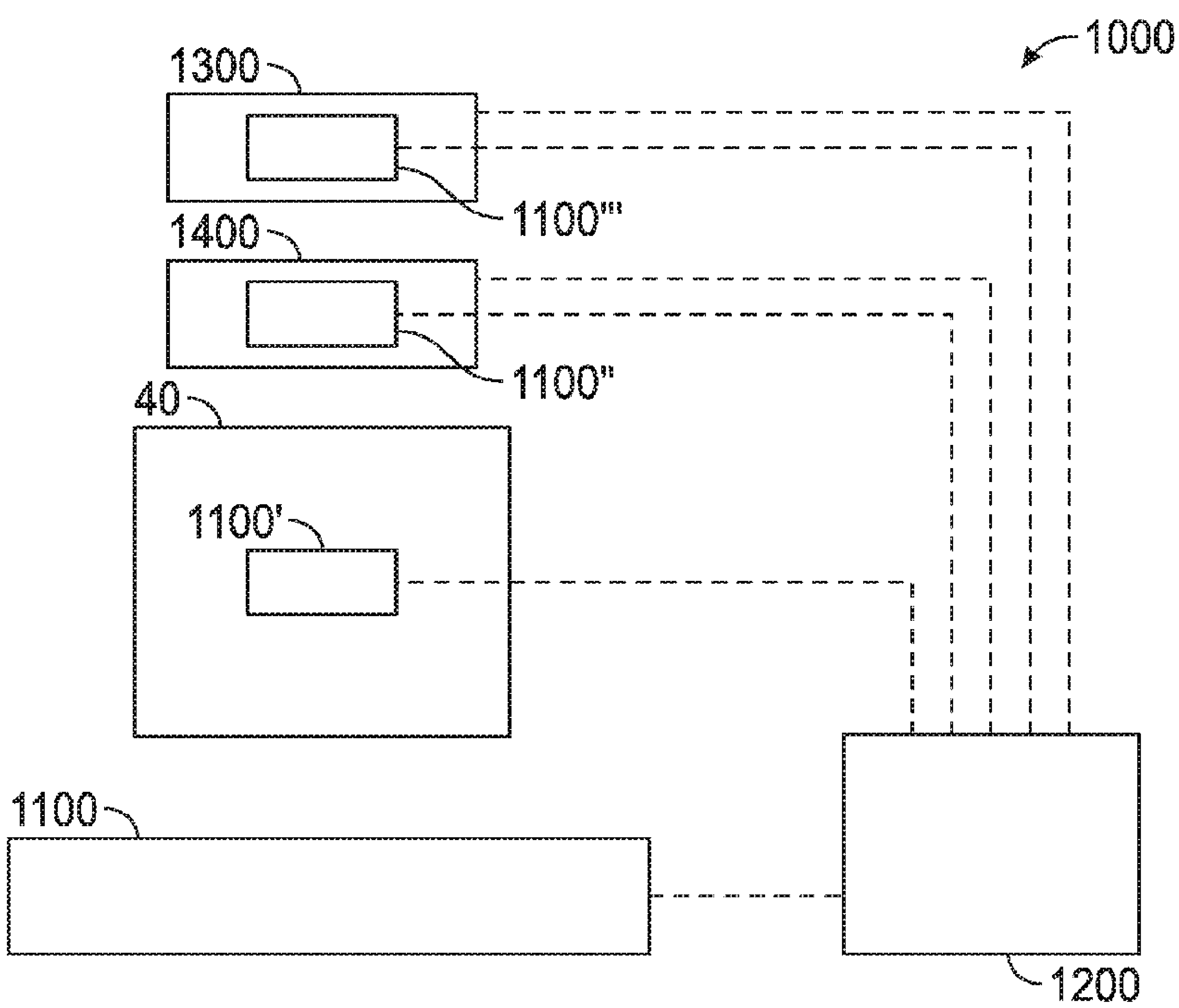

1000
1300
1100'''
1400
1100"
40
1100'
1100
1200

FIG. 24

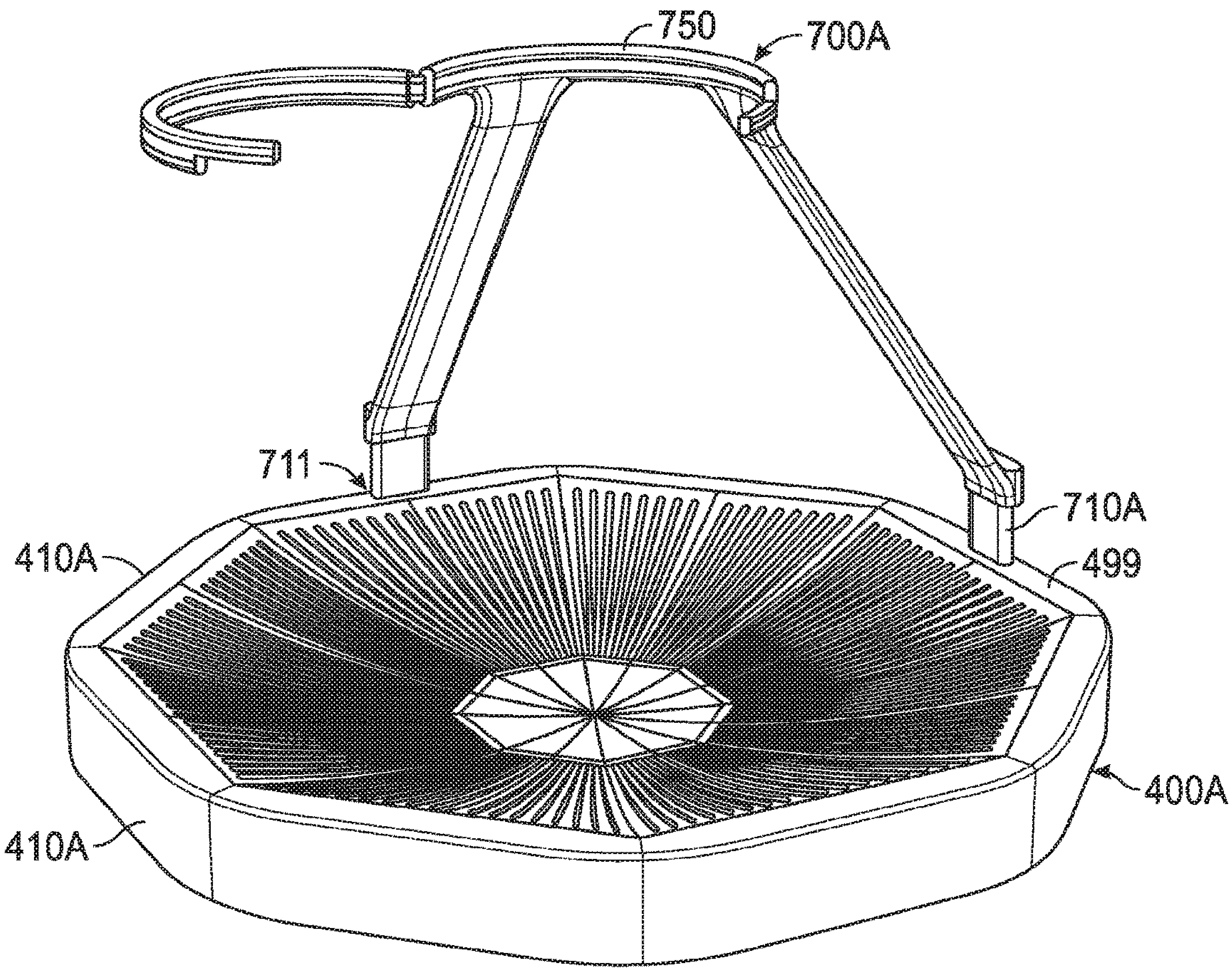


FIG. 25

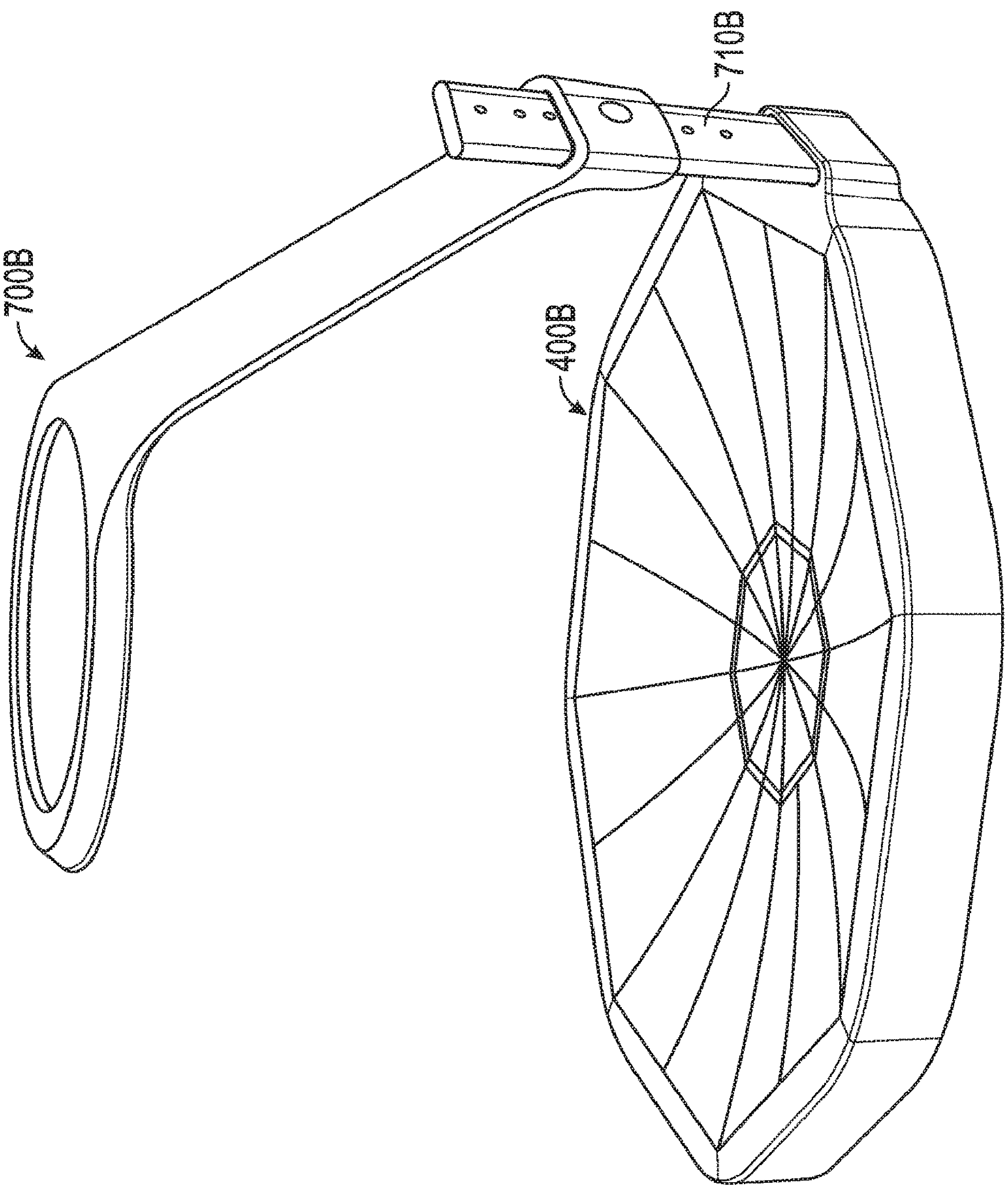


FIG. 26

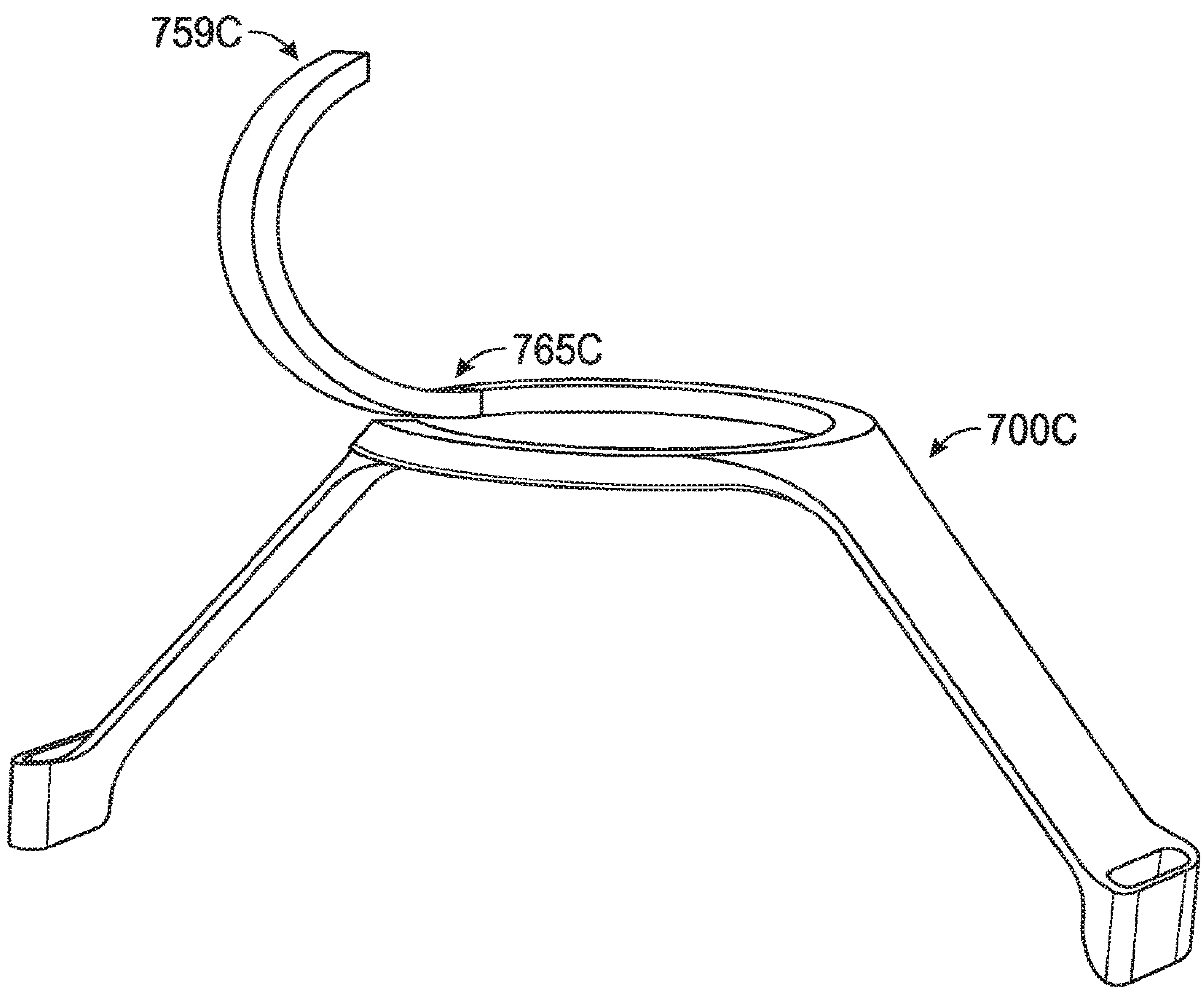


FIG. 27

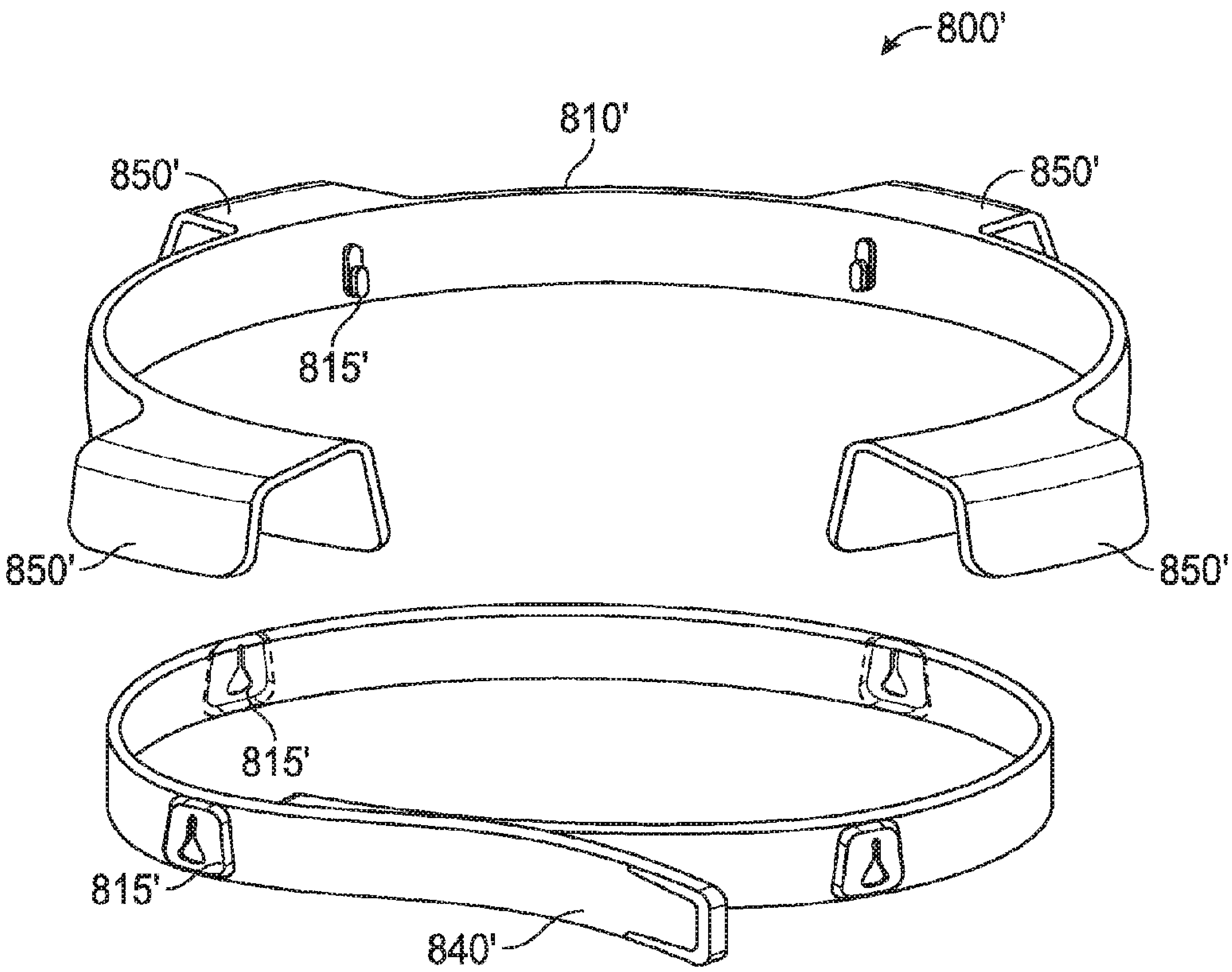


FIG. 28

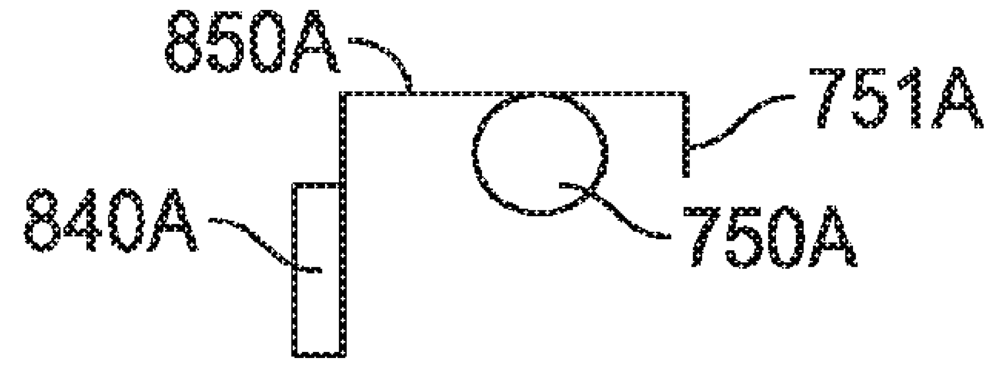


FIG. 29A

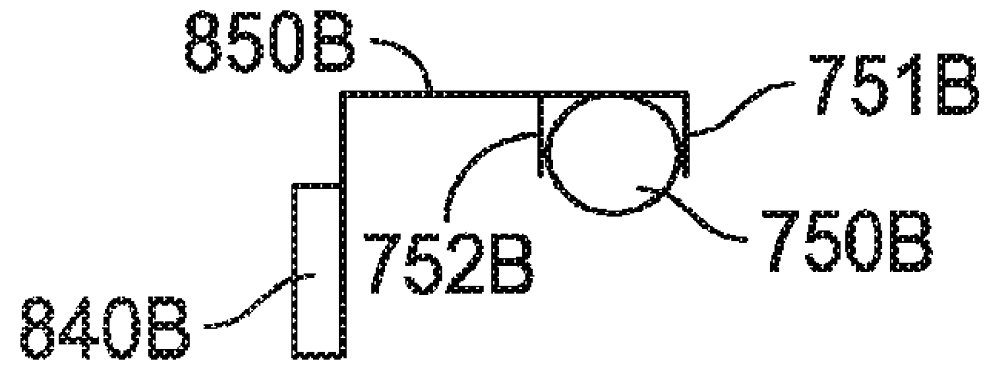


FIG. 29B

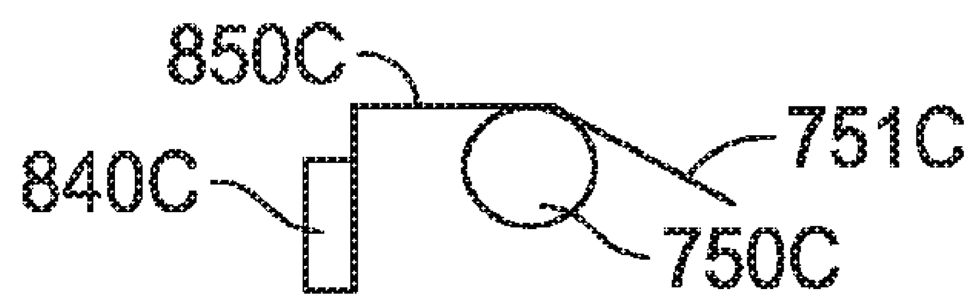


FIG. 29C

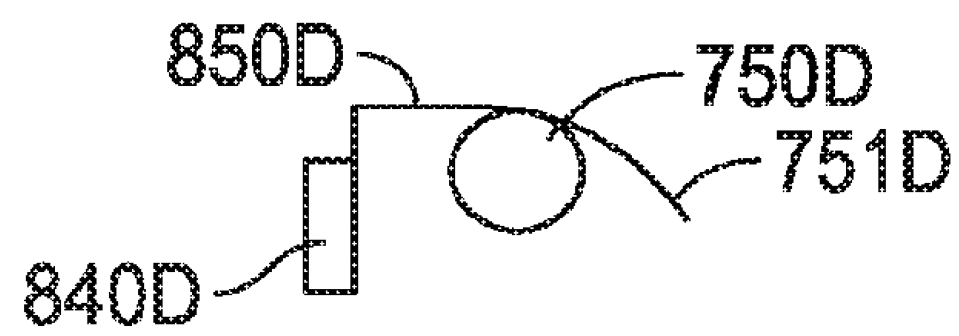


FIG. 29D

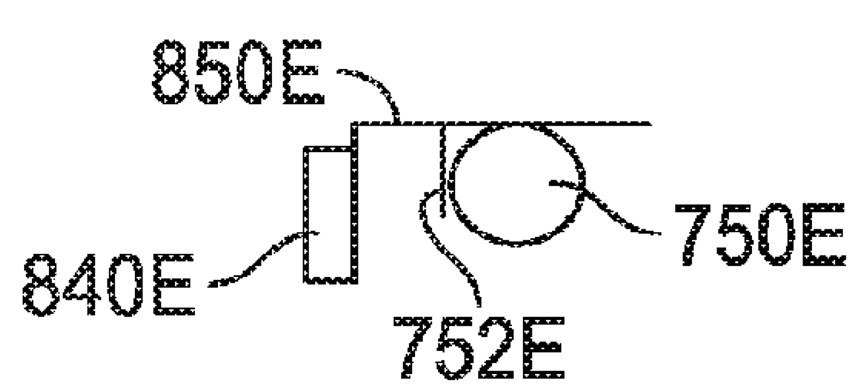


FIG. 29E

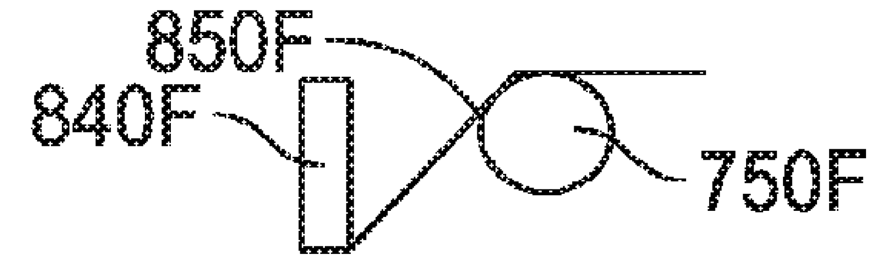


FIG. 29F

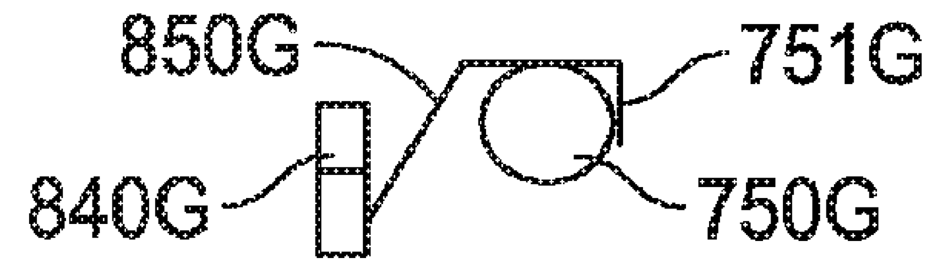


FIG. 29G

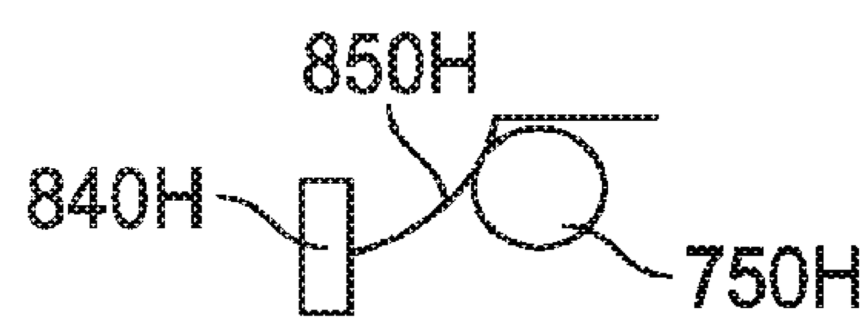


FIG. 29H

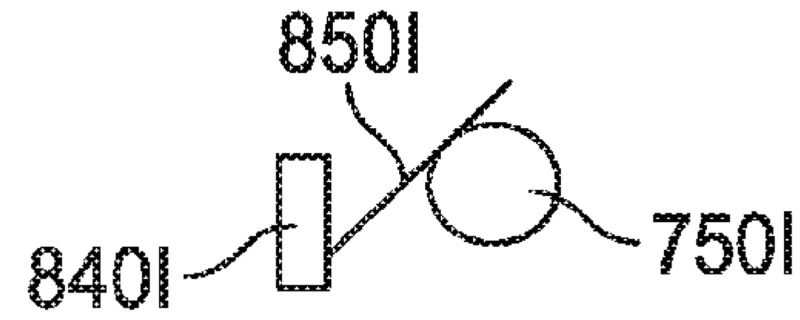


FIG. 29I

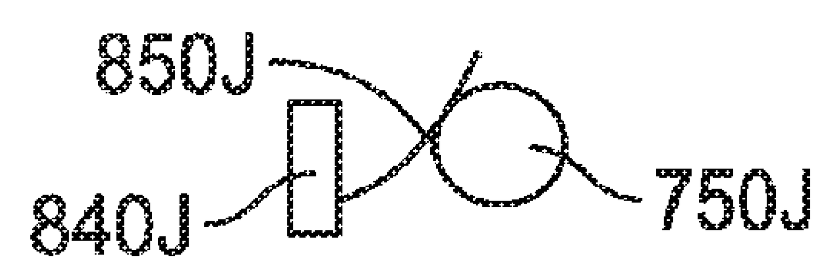


FIG. 29J

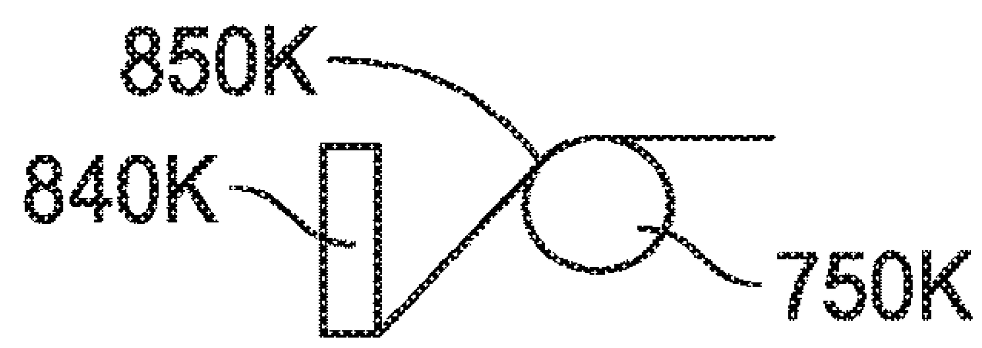


FIG. 29K

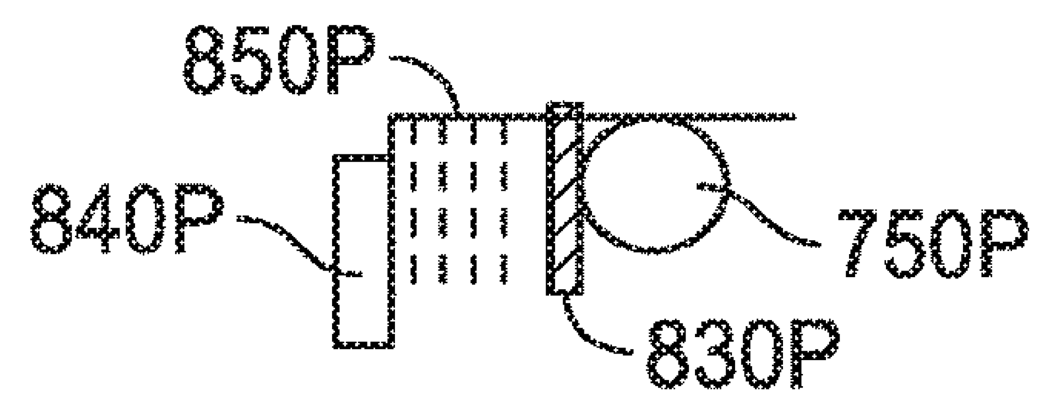


FIG. 29P

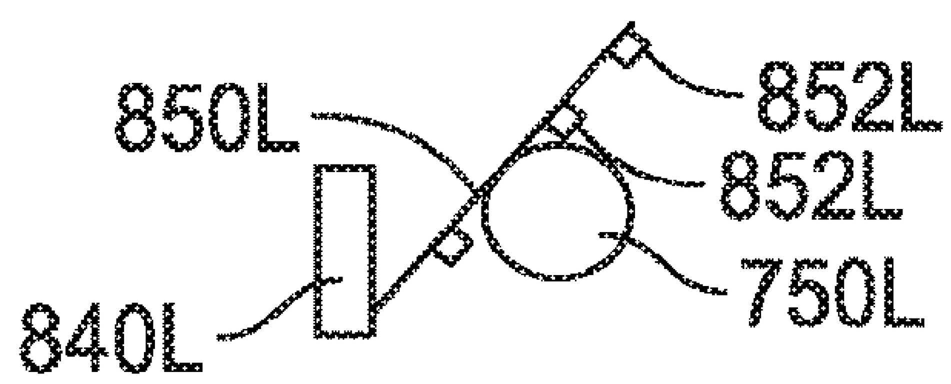


FIG. 29L

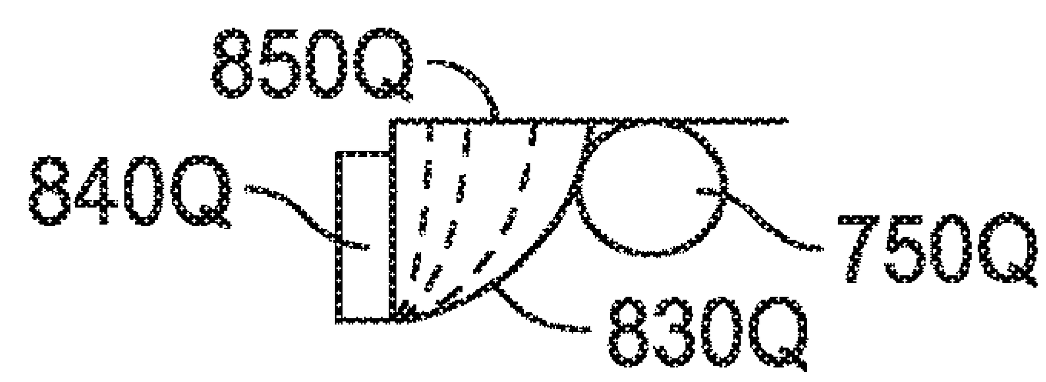


FIG. 29Q

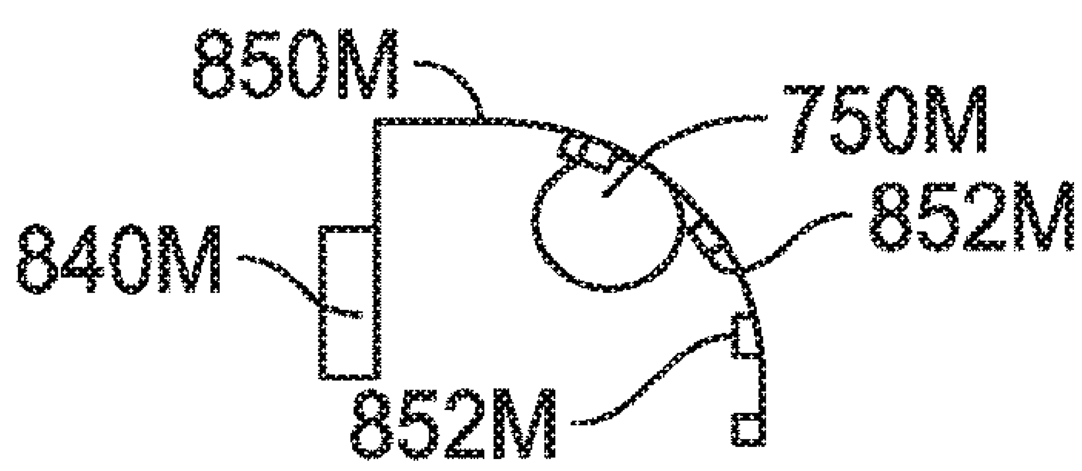


FIG. 29M

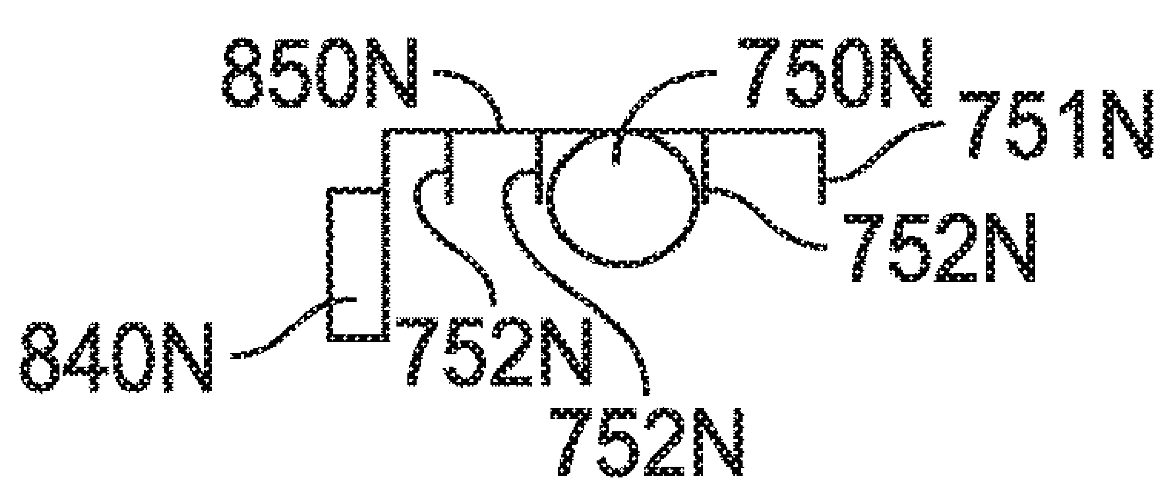


FIG. 29N

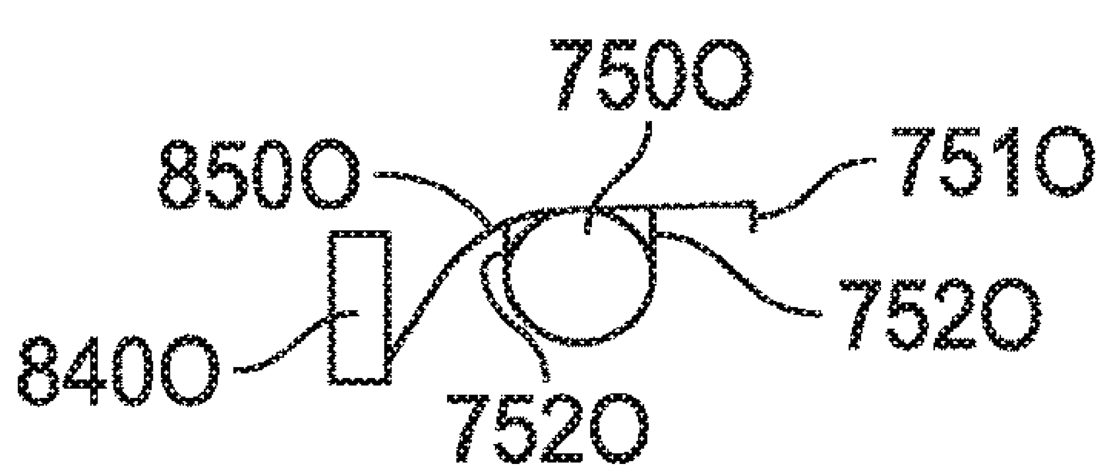


FIG. 29O

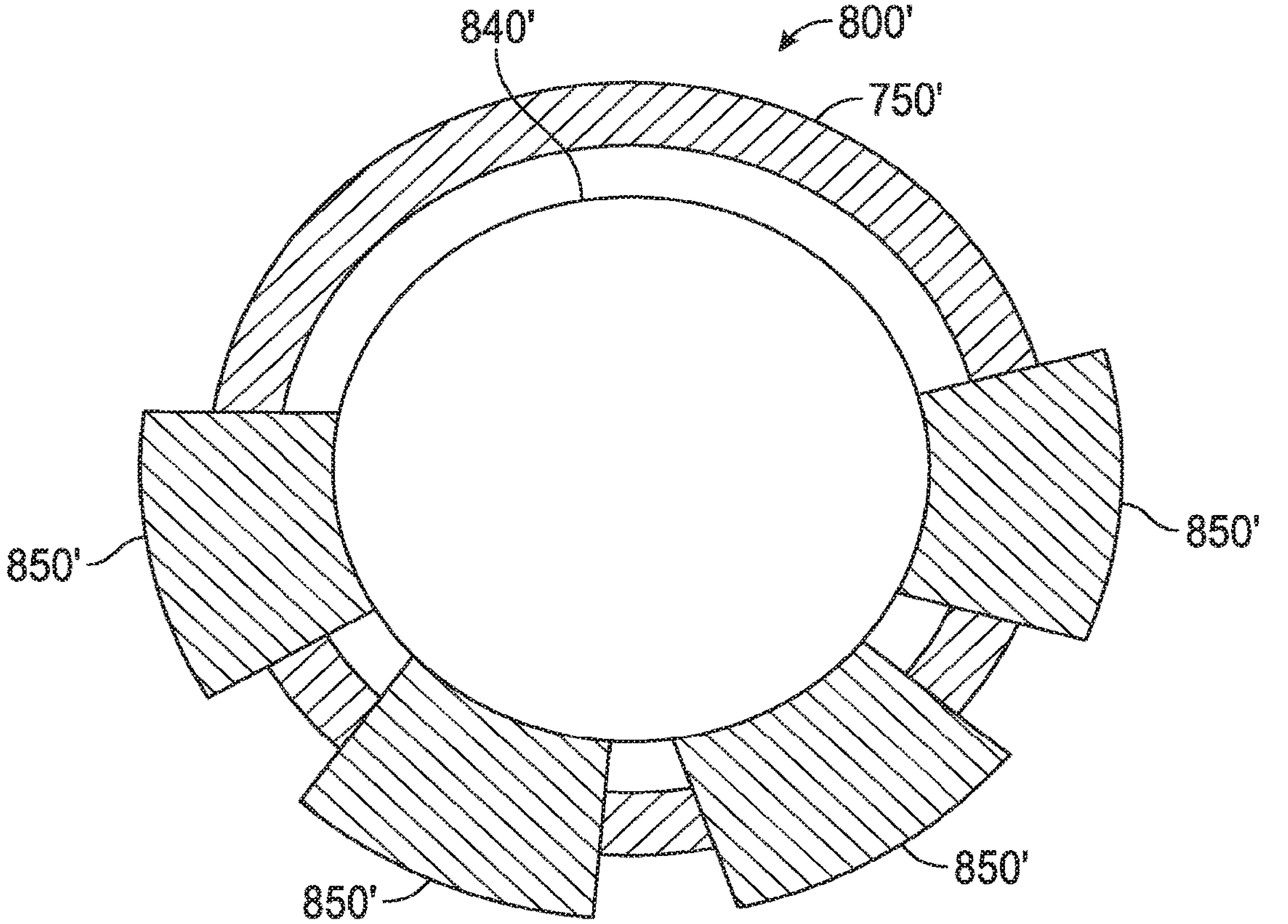


FIG. 30

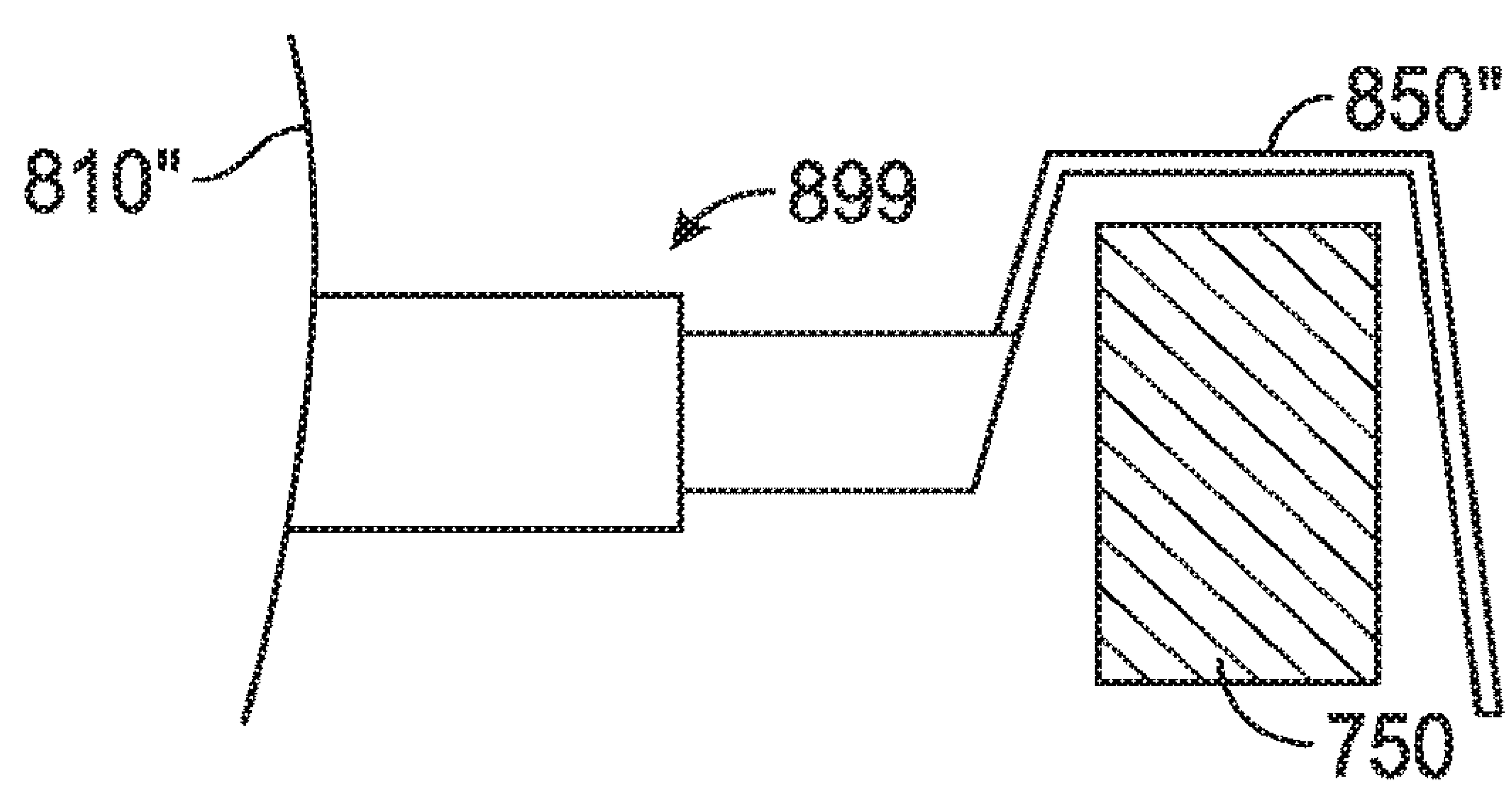


FIG. 31

LOCOMOTION SYSTEM AND APPARATUS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. patent application Ser. No. 14/062,625, filed Oct. 24, 2013, which claims benefit of U.S. Provisional patent application Ser. No. 61/717,761 filed Oct. 24, 2012, and entitled "Locomotion System and Apparatus," which is hereby incorporated herein by reference in its entirety. This application also claims benefit of U.S. provisional patent application Ser. No. 61/757,986 filed Jan. 29, 2013, and entitled "Locomotion System and Apparatus," which is hereby incorporated herein by reference in its entirety.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

Not applicable.

BACKGROUND

The present disclosure generally relates to locomotion devices that can be used m conjunction with virtual reality systems.

Within a virtual reality environment, users typically desire the ability to walk freely. In particular, the ability to physically walk or run in the real environment and have that motion translated to the virtual environment significantly increases the level of immersion of the user in the virtual environment. However, movement in the real world is often limited by physical space limitations (e.g., the size of the room within which the user is located). Accordingly, locomotion devices are designed to provide the user the sensation of walking freely, while confining the user to a specific location. For example, many locomotion devices allow a user to walk freely, in 360 degrees, on a platform having a finite size without ever leaving the platform.

Conventional locomotion devices include motorized and non-motorized designs, which may be used in conjunction with virtual reality environments in a multitude of applications including but not limited to gaming. Examples of applications beyond gaming include employee training; combat training; physical therapy; exercise; virtual work environments; virtual meeting rooms (for both professional and personal purposes); sports simulation and training; and virtual tourism, concerts, and events.

Motorized locomotion devices typically use sensors to detect the movement of the user and send feedback to motors driving belts or rollers on which the user moves. The belts or rollers are operated to counter the user's movements and bring the user back to a central portion of the platform after each step. There are many drawbacks to motorized locomotion devices. For example, the motorized locomotion devices are usually complex and expensive because of the rolling and motorized components, sensors, processing units, and feedback loops. In addition, complex algorithms are required for the rolling and motorized components to properly counter the movements of the user. Inaccurate feedback to the motor can result in erroneous movement of the belts or rollers that may cause the user to lose balance or drift away from the center of the platform. There may also be issues with latency of feedback and response when the user accelerates, causing incorrect movements or responses that are too slow, potentially allowing the user walk off the platform. Further, because the response movements of the

belts or rollers counteract the user's movements, the user may be prone to lose balance and trip.

In addition to issues with the operation of motorized locomotion devices, such devices are usually large and bulky, and thus, do not fit in the average-sized residential room (e.g., a game room, living room, or bedroom) and can be difficult to break up into modular pieces for shipping and storage. The devices are necessarily large, to prevent the user from walking off the platform before the correct system response has been processed; thus, rendering the devices unsuitable for in-home consumer usage.

Non-motorized locomotion devices lack motorized components and rely on the user's movement and/or gravity to bring the user back to the center of the platform after each step. Omni-directional ball bearing platforms, for example, have hundreds of ball bearings that allow the user to walk in place while a restraint around the user's waist keeps the user in place. A major issue with omni-directional ball bearing platforms is that the user does not experience a natural gait with a heel-toe strike movement, but rather instability similar to that of walking on ice. The instability results in the shuffling of feet where neither heel nor toe lift off the device, resulting in an unnatural walking gait that reduces the immersion of the user in the virtual environment. Moreover, these devices are typically heavy and expensive due to the plurality of rolling components.

Another non-motorized locomotion device is a saucer-like device with a smooth, upward facing concave surface. The user typically wears special shoes and then "walks" on the slick concave surface, repeatedly sliding his/her feet back and forth while his/her body remains primarily in the center of the device. Although saucer-like devices are relatively simple, small, and can fit in a residential room, there are several disadvantages. First, the user does not experience a natural gait with a heel-toe strike movement, but rather instability similar to that of walking on ice due to the low-friction properties of the concave surface and special shoes, which lack any foot-stabilizing elements. Thus, the user is forced to shuffle his/her feet to help maintain stability as opposed to employing a natural stepping motion. Further, there is no safety mechanism or device to prevent the user from falling during use.

Another non-motorized locomotion device is a large hollow spherical ball approximately feet in diameter. The user enters the ball through a replaceable panel and walks within the ball as the ball rotates about its center relative to the surrounding environment. The ball device also has several issues. First, it is difficult and unnatural to start and stop movement of the ball, which may result in user instability. Further, because the size of the ball is necessarily constrained, the walking area is not planar, which also results in a less natural walking experience. In addition to the ball device being too large to fit in a residential room, such commercially available balls are also cost-prohibitive for household consumers.

Accordingly, there remains a need for locomotion devices that allow users to safely access virtual environments in the privacy of the user's home and while providing the sensation of a more natural walking gait.

BRIEF SUMMARY OF THE DISCLOSURE

The embodiments described herein are generally directed to a locomotion system for use with a virtual environment technology comprising a platform configured to support a user, a harness support assembly coupled to the platform and extending upwardly from the platform, wherein the harness support assembly includes a support halo positioned above the platform and extending about a vertical central axis, and a safety harness configured to be worn by the user. The safety harness includes an interface structure moveably coupled to the support halo.

In an embodiment, a locomotion system for use with a virtual environment technology comprises a platform configured to support a user, a harness support assembly coupled to the platform and extending upwardly from the platform, wherein the harness support assembly includes a support halo positioned above the platform and extending about a vertical central axis, and a safety harness including a belt configured to be worn by the user, an interface structure coupled to the belt, and a vertical member coupled to the belt. The interface structure slidingly engages an upper surface of the support halo, and the vertical member is disposed within the support halo and is configured to limit the radial movement of the interface structure relative to the support halo.

In an embodiment, a virtual reality system comprises a locomotion system including a platform configured to support a user, a harness support assembly coupled to the platform, and a safety harness configured to be worn by the user. The harness support assembly includes a support halo positioned above the platform and extending about a vertical central axis, and wherein the safety harness is configured to move relative to the support halo. The virtual reality system further comprises a processing unit, a motion sensing device in communication with the processing unit and configured to detect and track the motion of the user, a visual display in communication with the processing unit, and a controller configured to be held by the user.

Embodiments described herein comprise a combination of features and advantages intended to address various shortcomings associated with certain prior devices, systems, and methods. The foregoing has outlined rather broadly the features and technical advantages of the invention in order that the detailed description of the invention that follows may be better understood. The various characteristics described above, as well as other features, will be readily apparent to those skilled in the art upon reading the following detailed description, and by referring to the accompanying drawings. It should be appreciated by those skilled in the art that the conception and the specific embodiments disclosed may be readily utilized as a basis for modifying or designing other structures for carrying out the same purposes of the invention. It should also be realized by those skilled in the art that such equivalent constructions do not depart from the spirit and scope of the invention as set forth in the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

For a detailed description of the preferred embodiments of the invention, reference will now be made to the accompanying drawings in which:

FIG. **1** is a top view of an embodiment of a locomotion system in accordance with the principles described herein;

FIG. **2** is a perspective exploded view of the locomotion platform of FIG. **1**;

FIG. **3***a* is a perspective view of a section of the locomotion platform of FIG. **1**;

FIG. **3***b* is a perspective view of a section of the locomotion platform of FIG. **1**;

FIG. **4***a* is a side view of a section of the locomotion platform of FIG. **1**;

FIG. **4***b* is a side view of an alternative embodiment of a section of a locomotion platform in accordance with the principles described herein;

FIG. **5***a* is a cross-sectional end view of the channels and ridges extending along the top surface of the section of FIG. **3***a;*

FIGS. **5***b*-**5***d* are cross-sectional end views of alternative embodiments of channels and ridges that can be provided in the top surface of the sections of locomotion platforms in accordance with the principles described herein;

FIG. **6***a* is a side view of an embodiment of a safety device in accordance with the principles described herein for use with the locomotion platform of FIG. **1**;

FIG. **6***b* is a top view of the safety device of FIG. **6***a;*

FIG. **7** is a perspective view of an embodiment of a foot covering in accordance with the principles described herein for use with the locomotion platform of FIG. **1**;

FIG. **8** is a bottom view of the foot covering of FIG. **7**;

FIG. **9** is a perspective view of the foot covering of FIG. **7** and a portion of the locomotion platform of FIG. **1**;

FIG. **10** is a perspective view of an embodiment of a locomotion system in accordance with the principles described herein;

FIG. **11** is a perspective view of a center zone and a section of the locomotion platform of FIG. **31**;

FIG. **12***a* is a perspective front view of a section of the locomotion platform of FIG. **31**;

FIG. **12***b* is a perspective rear view of a section of the locomotion platform of FIG. **31**;

FIG. **13***a* is a side view of a section of the locomotion platform of FIG. **31**;

FIG. **13***b* is a side view of an alternative embodiment of a section of a locomotion platform in accordance with the principles described herein;

FIG. **14** is a top view of a platform connection structure and a base of the locomotion platform of FIG. **31**;

FIG. **15** is a perspective view of a portion of the platform connection structure of FIG. **35**;

FIG. **16** is a perspective partial view of the platform connection structure of FIG. **35**;

FIG. **17***a* is a perspective partial view of locomotion platform of FIG. **31**;

FIG. **17***b* is an enlarged perspective partial view of the locomotion platform of FIG. **38***a;*

FIG. **18** is a perspective view of a portion of the base of FIG. **35**;

FIG. **19** is a top view of the system of FIG. **31**;

FIG. **20** is an enlarged perspective view of the support ring of locomotion system of FIG. **31**;

FIG. **21** is a perspective partial view of the support ring of FIG. **41**;

FIG. **22** is a perspective view of the safety harness of the locomotion system of FIG. **31**;

FIG. **23** is a perspective view of an embodiment of a foot covering in accordance with the principles described herein for use with embodiments of locomotion platforms described herein;

FIG. **24** is a schematic view of a virtual reality system for use with the locomotion system of FIG. **31**;

FIG. **25** is a schematic view of an embodiment of a safety harness support structure and locomotion system in accordance with the principles described herein;

FIG. **26** is a schematic view of an embodiment of a safety harness support structure and locomotion system in accordance with the principles described herein;

FIG. **27** is a schematic view of an embodiment of a safety harness support structure in accordance with the principles described herein for use with locomotion systems described herein;

FIG. **28** is a schematic view of an embodiment of a safety harness in accordance with the principles described herein for use with locomotion systems described herein;

FIGS. **29***a*-**29***q* are schematic cross-sectional views of different embodiments of safety harnesses and a support ring in accordance with the principles described herein for use with locomotion systems described herein;

FIG. **30** is a schematic top view of an embodiment of a safety harness in accordance with the principles described herein for use with locomotion systems described herein; and

FIG. **31** is a schematic cross-sectional side view of an embodiment of a safety harness and a support ring in accordance with the principles described herein for use with locomotion systems described herein.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The following discussion is directed to various exemplary embodiments. However, one skilled in the art will understand that the examples disclosed herein have broad application, and that the discussion of any embodiment is meant only to be exemplary of that embodiment, and not intended to suggest that the scope of the disclosure, including the claims, is limited to that embodiment.

Certain terms are used throughout the following description and claims to refer to particular features or components. As one skilled in the art will appreciate, different persons may refer to the same feature or component by different names. This document does not intend to distinguish between components or features that differ in name but not function. The drawing figures are not necessarily to scale. Certain features and components herein may be shown exaggerated in scale or in somewhat schematic form and some details of conventional elements may not be shown in interest of clarity and conciseness.

In the following discussion and in the claims, the terms "including" and "comprising" are used in an open-ended fashion, and thus should be interpreted to mean "including, but not limited to . . . ." Also, the term "couple" or "couples" is intended to mean either an indirect or direct connection. Thus, if a first device couples to a second device, that connection may be through a direct connection, or through an indirect connection via other devices, components, and connections. As another example, two components that contact each other or slidingly engage each other would be coupled. In addition, as used herein, the terms "axial" and "axially" generally mean along or parallel to a central axis (e.g., central axis of a body or a port), while the terms "radial" and "radially" generally mean perpendicular to the central axis. For instance, an axial distance refers to a distance measured along or parallel to the central axis, and a radial distance means a distance measured perpendicular to the central axis.

The locomotion device and system disclosed herein employs a platform, a safety assembly, and variable-friction foot coverings that are intended to address certain shortcomings associated with previous locomotion devices. The locomotion device allows the user to use his/her natural gait while exercising freedom of movement in the physical world that translates to movement in a virtual environment.

Referring now to FIG. **1**, an embodiment of a locomotion system **10** in accordance with the principles described herein is shown. In this embodiment, locomotion system **10** includes a base or platform **100**, a safety assembly **200** coupled to platform **100**, and variable-friction shoes or foot coverings **300**. As will be described in more detail below, the user of system **10** stands and moves on platform **100** using shoes **300**, while safety assembly **200** provides a means to protect the user during use of system **100**.

Referring now to FIGS. **2** and **3***a*, in this embodiment, platform **100** has a vertical central axis **105** and includes eight circumferentially adjacent generally triangular sections **110**. Each platform section **110** has a planar bottom or lower surface **120**, a planar back face **130**, a planar left side face **140**, and a planar right side face **150**, and a top or upper surface **160**. Faces **130**, **140**, **150** extend perpendicularly upward from lower surface **120**, however, as will be described in more detail below, an inner portion of upper surface **160** is oriented parallel to lower surface **120** and an outer portion of upper surface **160** is oriented at an acute angle relative to lower surface **120**. Platform sections **110** are arranged circumferentially adjacent one another such that the entirety of each left face **140** abuts the entirety of a right face **150** of an adjacent section **110**. Since each platform section **110** is identical in this embodiment, platform **100** is a regular polygon—having all sides the same length that are symmetrically placed about a common central point. In particular, since eight sections **110** are provided in this embodiment, when all platform sections **110** are properly aligned, platform **100** forms an octagon shape. However, in other embodiments, different numbers of platform sections (e.g., sections **110**) may be provided, resulting in different geometries for platform **100**. For example, a platform having six circumferentially adjacent sections will have a hexagonal shape. Platform **100** preferably has a diameter or maximum horizontal width between 3.0 and 6.0 feet, and more preferably between 3.5 and 4.5 feet.

Referring now to FIGS. **3***a* and **3***b*, each platform section **110** includes a center zone **170**, a plurality of channels or grooves **180**, a through hole **190**, and a coupling mechanism **135**. Sections **110** each have a length L_{110} (measured horizontally from an inner edge **175** at axis **105** to back face **130**) preferably between 18.0 and 34.0 inches, a width W_{110} (as measured horizontally along back face **130** between the left and right side faces **140**, **150**) preferably between 16.0 and 30.0 inches, and a height H_{110} (as measured vertically between the top and bottom faces **160**, **120**, respectively, along the back face **130**) preferably between 2.0 and 12.0 inches. Each section **110** is constructed from a single material that has a low coefficient of friction, such as high density polyethylene, low density polyethylene, polyvinyl chloride, polypropylene, or any other suitable material with a low coefficient of friction.

Bottom face **120** lies in a plane, and is triangular with outer end points **120***a*, **120***b* that are equidistant from inner end point **120***c*. When describing the individual sections **110** of platform **100**, the terms "inner" and "outer" are used in reference to the assembled platform **100** as shown in FIG. **1** where the outer edges of the platform **100** coincide with the back face **130** of each section **110** and the center of platform **100** coincides with the inner edge **175** of each section **110**, which is coaxial with central axis **105**. Inner edge **175** comprises an upper end **175***a* and a lower end **175***b*. Inner end point **120***c* of the bottom face **120** is coincident with central axis **105** and lower end **175***b* of inner edge **175**.

Back face **130** lies in a plane oriented perpendicular to bottom face **120**, extends from bottom face **120** axially upward to upper surface **160**, and has upper edge **130***a*, lower edge **130***b*, left edge **130***c*, and right edge **130***d*. The left and right side faces **140**, **150**, also oriented perpendicular to bottom face **120**, extend from left and right edges **130***c*, **130***d* of back face **130** and terminate at inner edge **175**. In the present embodiment, the angle A_{145} between the left and right side faces **140**, **150** is 45 degrees. It should be appreciated that angle A_{145} is dependent upon the number of sections **110** used to form platform **100**. For example, as previously discussed, in an embodiment, platform **100** may be made up of six sections **110**, then angle A_{145} would be 60 degrees. In another embodiment, platform **100** may be made up of nine sections **110** with an angle A_{145} of 40 degrees.

Referring now to FIGS. **3***a*, **3***b*, and **4***a*, top surface **160** includes a center zone **170** and an angled portion **161**. Center zone **170** comprises top face **170***a*; edge **170***b*, which is parallel to back face **130**; and upper end point **175***a* of inner edge **175**, which are coincident with axis **105**. The triangular center zone top face **170***a* lies in a plane oriented parallel to bottom face **120**. Center zone **170** has a length L_{170} (as measured horizontally between edge **170***b* and upper end point **175***a*) preferably between 5.0 and 10.0 inches, a width W_{170} (as measured along edge **170***b* between the left and right side faces **140**, **150**) preferably between 4.0 and 8.0 inches, and a height H_{170} (as measured vertically between the center zone top face **170***a* and bottom face **120** along inner edge **175**) preferably between 0.25 and 2.0 inches. Though shown in the present embodiment parallel to bottom face **120**, triangular center zone top face **170***a* may be curved such that upper end point **175***a* is disposed axially lower along axis **105** than edge **170***b*. In this alternative embodiment, edge **170***b* extends radially toward inner edge **175** and axially downward toward upper end point **175***a* while bulging downward toward bottom face **120**.

As best shown in FIGS. **3***b* and **4***a*, angled portion **161** of top surface **160** includes top face **161***a*; back edge **161***b*, which is coincident with back face edge **130***a*; and front edge **161***c*, which is coincident with center zone edge **170***b* and parallel to back face **130**. Top face **161***a* lies in a plane and extends from outer edge **130***a*, **161***b* radially and axially downward toward edge **161***c*, **170***b* such that the angle A_{160} between the plane defined by top face **161***a* and the plane defined by center zone top face **170***a* is preferable between 5.0 and 18.0 degrees. In an alternative embodiment, shown in FIG. **4***b*, angled portion **161** of top surface **160** comprises top face **162***a*, back edge **162***b*, which is coincident with back face edge **130***a*; and front edge **162***c*, which is coincident with center zone edge **170***b* and parallel to back face **130**. Top face **162***a* defines a curved surface that extends from outer edge **162***b* radially toward inner edge **170***b* and axially downward toward center zone top face **170***a* while bulging downward toward bottom face **120**.

Referring again to FIGS. **3***a* and **3***b*, angled portion **161** also includes a plurality of channels or grooves **180** and ridges **185** that extend radially from back face **130** to edge **170***b*. As best shown in FIG. **5***a*, each channel **180** has a left interior edge **180***a*, a right interior edge **180***b*, and a bottom interior edge **180***c*. Left edge **180***a* is parallel to right edge **180***b*, and in this embodiment, both left and right edges **180***a*, **180***b* are orthogonal to bottom edge **180***c*. Each channel **180** has a width W_{180} preferably between 0.20 and 1.0 inch and a depth D_{180} preferably between 0.05 and 1 inch.

Referring still to FIG. **5***a*, each ridge **185** comprises a left exterior edge **185***b*, a right exterior edge **185***a*, and a top exterior edge **185***c*. Left exterior edge **185***b* is coincident with right interior edge **180***b* of channel **180** and is parallel to right exterior edge **185***a*, which is coincident with left interior edge **180***a* of channel **180**. Both left and right exterior edges **185***b*, **185***a* are orthogonal to top exterior edge **185***c*. Each channel **180** has a height H_{185} preferably between 0.05 and 1 inch. However, the width, as will be discussed below in further detail, will vary depending on the quantity and size of the channels **180**.

In the embodiment shown in FIG. **5***a*, the lower corners **180***d* where the left and right edges **180***a*, **180***b* connect to the bottom edge **180***c* are rounded, and the upper corners **180***e* of channel **180** where the left and right edges **180***a*, **180***b* connect to the top surface **160** of section **110** are rounded. The horizontal length L_{180e} of the curved portion of the corner **180***e* (as measured from the right edge **180***b* to the flat portion of top surface **160**) can be increased or decreased as desired.

Referring now to FIGS. **5***b* and **5***c*, and using similar nomenclature for the left (**181***a*, **182***a*), right (**181***b*, **182***b*), bottom interior edges (**181***c*, **182***c*), and lower (**181***d*, **182***d*) and upper corners (**181***e*, **182***e*), the horizontal length L_{181e}, L_{181e} of the curved portion of the upper corner **181***e*, **182***e* (as measured from the left edge **181***a*, **182***a* to the flat portion of top surface **160**) can be increased or decreased as desired. For example, the curved length L_{181e} of the embodiment shown in FIG. **5***b* is less than the curved length L_{182e} of the embodiment shown in FIG. **5***c*.

Referring now to FIG. **5***d*, in another embodiment, the bottom interior edge **183***c* forms a semicircle with a diameter equal to the horizontal distance between the left and right edges **183***a*, **183***b*. Corners **180***d* can, thus, vary from having ninety degree angles (between left and right edges **180***a*, **180***b* and bottom edge **180***c*), rounded ninety degree angles as shown in FIG. **5***a*, to having angles greater than ninety degrees but less than 180 degrees.

The foregoing discussion is directed to the geometry of the grooves **180** and ridges **185** at the back face **130** of platform section **110**. However, the height H_{185} of the ridges **185** begins to taper (i.e., decrease) as the grooves **180** and ridges extend toward center zone **170**. Ridge height H_{185} becomes gradually shorter until the top edge **185***c* of ridge **185** connects to center zone top face **170***a* at center zone inner edge **170***b*. The geometry and dimensions of the channels or grooves **180** remains unchanged as the ridges **185** diminish in height.

Each section **110** preferably comprises 16-18 channels **180**; however, in general, the number of channels **180** can vary depending on the dimensions of each section **110** including the center zone **170** and the width W_{180} of each channel **180**. Similarly, the quantity of ridges **185** will also vary depending on the quantity and dimensions of the channels **180** as well as the dimensions of each section **110**. In the embodiment shown in FIG. **3***a*, section **110** has a length L_{110} of 24.0 inches and 17 channels **180** that may be 0.20 to 0.375 inch wide and spaced approximately 0.79 to 0.97 inch apart; thus, the 16 ridges **185** may be 0.79 to 0.97 inch wide.

In another embodiment, the width W_{180} of the channels **180** may vary between outer edge **130***a* and center zone **170**. For example, the width of a channel **180** may be greater at outer edge **130***a* than at center zone edge **170***b*. In yet another embodiment, the depth D_{180} of channels **180** may be less than 0.5 inch and the width W_{180} of the channels **180** may be less than 0.2 inch, allowing each section **110** to comprise more than 18 channels **180** such that the ridges **185** form soft raised ribs on the upper surface **160** of each section **110**.

Referring now to FIG. **3***b*, vertical through hole **190**, having central axis **195** parallel to central axis **105**, includes a curved side wall **190***a* and a planar side wall **190***d* connected at end points **190***b*, **190***c* to form a through hole with a semicircle shaped cross section that extends from top surface **160** downward to bottom face **120**. Through hole **190** is disposed proximal to left edge **130***c* of back face **130**—approximately equidistant to back face **130** and left face **140**—and with axis **195** oriented parallel to axis **105**, back face **130**, and left face **140**. In the present embodiment, through hole **190** is oriented such that planar side wall **190***d* is orthogonal to left side wall **140** of platform section **110**. Through hole **190** also has a diameter D_{190} (shown in FIG. **3***a*) preferably between 0.8 and 1.25 inches (as measured between end points **190***b*, **190***c*) that is preferably 0.5 to 2.0 inches away from back face **130** and left face **140**.

Through hole **190** may be located anywhere along and proximal to back face **130**, including for example but not limited to proximal to right face **150** or equidistant between left and right faces **140**, **150**. Though shown in the present embodiment as a semicircle, through hole **190** may be of any shape including but not limited to a circle, ellipse, square, rectangle, or polygon. Further, through hole **190** may be oriented or rotated in various ways, for example, the semicircle shape may be rotated in place to change the location of the curved side wall **190***a*. In addition, central axis **195** of through bore **190** may be oriented at an angle either toward or away from central axis **105** of platform **100** at an angle preferably between 0.1 and 45.0 degrees. Further, as shown in FIG. **1**, through hole **190** is disposed on alternating section **110** of platform **100**, such that half the section **110** do not include a through hole **190**. However, in another embodiment, through hole **190** may be disposed on every section **110**.

Referring now to FIGS. **3***a* and **3***b*, each coupling mechanism **135** includes a fastener **134** with four through holes **133** and two receptacles or cutouts **136***a*, **136***b* with four boreholes **138**. Each generally rectangular connector receptacle or cutout **136***a*, **136***b* is disposed on back face **130**. One receptacle **136***a* is disposed proximal to left side **140** and one receptacle **136***b* is disposed proximal to right side **150**. Both receptacles or cutouts **136***a*, **136***b* are disposed approximately halfway between top surface **160** and bottom face **120** and extend from side face **140**, **150** to inner cutout edge **137***b* and axially extend along central axis **105** from upper cutout edge **137***c* down to lower cutout edge **137***d*. Back face **137***a* of cutouts **136***a*, **136***b* defines a plane that is parallel to the plane defined by back section face **130**. Each cutout **136***a*, **136***b* has a height preferably between 0.5 and 2.2 inches, length preferably between 1.0 and 3.7 inches, and depth preferably between 0.1 and 1.0 inches. In an alternative embodiment, cutouts **136***a*, **136***b* need not be used and, instead, coupling mechanism **135** comprises fasteners **134** with through holes **133** that correspond to boreholes **138** and are secured with screws **132**.

Referring now to FIG. **3***b*, each cutout **136***a*, **136***b* further comprises two boreholes **138** disposed orthogonal to and extending from back cutout face **137***a*. In the present embodiment, boreholes **138** are spaced equidistant between inside cutout edge **137***b* and platform section side face **140**, **150** as well as equidistant between upper and lower cutout edges **137***c*, **137***d*. In another embodiment, boreholes **138** may be staggered between upper and lower cutout edges **137***c*, **137***d* to form a diagonal pattern. Each borehole **138** has a diameter preferably between 0.05 and 0.25 and a depth preferably between 0.1 and 1.0 inch.

Referring now to FIG. **3***a*, each connector or fastener **134** has a first rectangular side **134***a* releasably secured to platform section **110** and a second rectangular side **134***b* extending outward from first rectangular side **134***a* and left face **140**, with the second side **134***b* not connected to a platform section **110**. In the present embodiment, second side **134***b* would connect to cutout **136***b* disposed proximal to the right side **150** of an adjacent platform section **110** (not shown in FIG. **3***a*). First and second rectangular sides **134***a*, **134***b* are symmetrical about an axis defined by left edge **130***c* of back face **130**. The angle between the plane defined by first side **134***a* and the plane defined by second side **134***b* is dependent on the number of platform sections **110** and is preferably between 120.0 and 150.0 degrees, and more preferably 135.0 degrees. Each connector side **134***a*, **134***b* has a height preferably between 0.25 and 2.0 inches, length preferably between 0.75 and 3.5 inches, and thickness preferably between 0.05 and 1.0 inch.

Each connector **134** further comprises four through holes **133** that align with bore holes **138** when connector **134** is placed in cutouts **136***a*, **136***b*. Connectors **134** may be employed as a standalone connector or in conjunction with any suitable fastener standard in the art, including but not limited to a bracket, latch, drawbolt, hinge, or clip. Whether used standalone or with other fasteners, connectors **134** are releasably secured to boreholes **138** in platform sections **110** with screws **132** or other suitable fasteners standard in the art; thus, securing adjacent platform sections **110** together. Though shown in FIGS. **3***a* and **3***b* as rectangular, cutouts **136***a*, **136***b* may be any suitable shape, including but not limited to circular, elliptical, square, semi-circular, or polygonal.

Referring now to FIGS. **6***a* and **6***b*, in this embodiment, safety assembly **200** includes a vertical member **210** with central axis **205**, a pair of horizontal bars **220**, **221** pivotally connected to vertical member **210**, a pair of support bars **230**, **231** pivotally connected to horizontal bars **220**, **221** and slidingly connected to vertical member **210**. Vertical member **210** is a bar with a top end **210***a* and a bottom end **210***b*, and has a semicircle cross section configured to mate and slidingly engage hole **190**. Vertical member **210** has a height H_{210} preferably between 24.0 and 48.0 inches, and more preferably between 30.0 and 42.0 inches, and a diameter or width (for non-circular shaped vertical member **210**) preferably between ¾ and 1 inch.

Vertical member **210** also includes a first and second slot **215***a*, **215***b* with top slot end **210***c* disposed proximal to top end **210***a* and extending downward to bottom slot end **210***d*. First slot **215***a* is disposed at angle A_{215} about central axis **205** from the second slot **215***b*. Angle A_{215} is dependent on the number of platform section **110** and preferably between 120 and 150 degrees, and more preferably 135 degrees. Each slot **215***a*, **215***b* further comprises a lip (not shown) such that the opening of recessed strips **215***a*, **215***b* is narrower than the interior of recessed strips **215***a*, **215***b*. Vertical member **210** may be made of any suitable material known in the art, including but not limited to metals or polymers.

Referring now to FIG. **6***b*, horizontal bars **220**, **221** comprise an outside end **220***a*, **221** *a*, respectively, an inside end **220***b*, **221***b*, respectively, and a support bar connection point **220***c*, **221***c*, respectively. In this embodiment, horizontal bars **220**, **221** have a semicircle cross section; a length L_{220}, L_{221} preferably between 15.0 and 28.0 inches, and more preferably between 18.0 and 24.0 inches; and a diameter or width (for non-circular shaped horizontal bars **220**, **221**) preferably between ¾ and 1 inch. Horizontal bars **220**, **221** are pivotally connected to vertical member **210** at inside end **220**b, **221**b. In general, horizontal bars **220**, **221** can be pivotally connected to vertical member **210** with a hinge, pin, or other suitable connector that allows horizontal bars **220**, **221** to pivot at inside end **220**b, **221**b. Horizontal bars **220**, **221** may be made of any suitable material known in the art, including but not limited to metals or polymers, but are preferably made of a metal or polymer bar that is covered with a shock-absorbing polymer, such as rubber.

Referring again to FIGS. **6**a and **6**b, support bars **230**, **231** comprise a first end **230**a, **231** a and a second end **230**b, **231**b. In this embodiment, support bars **230**, **231** have a circular cross section; a length L_{230}, L_{231}, respectively, preferably between 6.0 and 24.0 inches, and more preferably between 12.0 and 18.0 inches; and a diameter preferably between 0.5 and 1 inch. Support bars **230**, **231** are pivotally connected to horizontal bars **220**, **221**, respectively, at first ends **230**a, **231**a, respectively. In general, support bars **230**, **231** may be pivotally connected to horizontal bars **220**, **221** with a hinge, pin, or other suitable connector that allows support bars **230**, **231** to pivot at first end **230**a, **231**a. Support bars **230**, **231** are slidingly connected to vertical member **210** at second ends **230**b, **231**b, respectively, which are retained in slots **215**a, **215**b, respectively, with protrusions or pins that are retained by the lip of slot **215**a, **215**b. Support bars **230**, **231** may be made of any suitable material known in the art, including but not limited to metals or polymers.

A release button (not shown) is preferably provided on vertical member **210** proximal to top recess end **210**c of vertical member **210**. A coupling mechanism (not shown) is preferably provided on safety assembly **200** to work in conjunction with the release button. The release button and coupling mechanism may be made of any suitable material known in the art, including but not limited to metals or polymers.

Though safety system **200** is shown in the present embodiment as groupings of interconnected bars, safety system **200** may comprise any suitable system known in the art that helps prevent injury to the user from falling during usage of the locomotion system **10**. For example, in other embodiments, safety system **200** may comprise a harness worn by the user and mounted to a stationary object.

In an unactuated state, horizontal bars **220**, **221** and support bars **230**, **231** are collapsed or folded down on approximately either side of vertical member **210**. Second end **230**b, **231**b of each support bar **230**, **231** is disposed proximal to bottom recess end **210**d of vertical member **210**. To actuate the horizontal bars **220**, **221**, the second end **230**b, **231**b of support bars **230**, **231** slides axially upward along axis **205** within recess strip **215**a, **215**b until second end **230**b, **231**b engages the coupling mechanism. The upward movement of second end **230**b, **231**b raises horizontal bars **220**, **221** from a vertical or subvertical position by pivoting at both the support bar **230**, **231** connection (second end **230**b, **231**b) to horizontal bar **220**, **221** and the horizontal bar connection (inside end **220**b, **221**b) to vertical member **210** to bring horizontal bars **220**, **221** to a horizontal or near horizontal position. In the actuated state, horizontal bars **220**, **221** are disposed orthogonal to central axis **205**. In another embodiment, horizontal bars **220**, **221** may be disposed at an angle that is greater than or less than 90 degrees from central axis **205**.

Horizontal bars **220**, **221** may be lowered by actuating the release button; thus, allowing the support bars **230**, **231** to slide downward within recessed strips **215**a, **215**b along central axis **205**. The downward movement of second end **230**b, **231**b lowers horizontal bars **220**, **221** from a horizontal or subhorizontal position by pivoting at both the support bar **230**, **231** connection (second end **230**b, **231** b) to horizontal bar **220**, **221** and the horizontal bar connection (inside end **220**b, **221**b) to vertical member **210** to bring horizontal bars **220**, **221** to a vertical or near vertical position.

Referring to FIGS. **7** and **8**, an embodiment of a foot covering **300** for use with embodiments of platforms described herein is shown. In this embodiment, foot coverings **300** comprise an upper portion **310**, a pair of closure straps **320**, a sole **330**, a plurality of variable friction pads **340-360**, **380-385**, and an anchor pin **390**. As used herein, the term "foot covering" refers to a shoe or an overshoe. An overshoe is a foot covering that at least partially covers the wearer's shoe and generally includes a sole and a means to attach the sole to the wearer's shoe or body (e.g., foot, ankle, or leg). Further, when used to describe foot covering **300**, the terms "top" or "bottom" may be used for purposes of description with "up," "upper," "upward," or "above" meaning generally toward or closer to the end of foot covering **300** closest to the toe **301**, and with "down," "lower," "downward," or "below" meaning generally toward or closer to the end of foot covering **300** closest to the heel **302**. The overall length and width of foot covering **300** will vary depending on the size of the wearer's foot; thus, foot covering **300** may be customized to fit any sized foot.

Upper portion **310** of foot covering **300** generally covers a portion of or the entire upper part of the wearer's foot. In the present embodiment, upper portion **310** covers the toe **301**, heel **302**, and sides **303**, **304** of the wearer's foot. Upper portion **310** may be made of any suitable material known in the art, including but not limited to fabric, leather, or other suitable material known in the art.

Referring now to FIG. **7**, closure straps **320** and retainers **325** are disposed on opposite sides of upper portion **310**. Closure straps **320** have a width preferably between 0.5 and 2.0 inches and length preferably between 6.0 and 12.0 inches long. Closure straps **320** extend over the top of the wearer's foot to retainer **325** disposed on opposite upper portion **310** side in which closure strap **320** originated. In this embodiment, retainer **325** comprises a slot through which closure strap **320** is threaded, allowing closure strap **320** to fold over itself and extend back toward upper portion **310** side in which closure strap **320** originated; hook and loop closures may be used on adjacent surfaces of closure straps **320** to secure closure straps **320**. However, in general, other suitable retention mechanisms known in the art including, without limitation, a hook and loop fastener, buckle, button, snap, elastic closure, or shoelaces can be employed.

Referring again to FIGS. **7** and **8**, sole **330** of foot covering **300** covers the underside of the wearer's foot and connects to upper portion **310** along the entire perimeter of the wearer's foot. In this embodiment, upper portion **310** and sole comprise one continuous piece of material.

Sole **330** comprises three sections—a forefoot **335**, a midfoot **365**, and a hindfoot **375**. Forefoot section **335** includes toe friction pad **340** and a first, second, and third forefoot pad **350**, **355**, **360**, respectively. Toe friction pad **340** is disposed on the bottom of sole **330** proximal to the toe **301** or the "top" of sole **330**. Toe friction pad **340** extends from the top of toe **301** downward toward heel **302** preferably between 0.5 and 1.5 inches and from one side **303** across the entire width of sole **330** to the other side **304**. First friction pad **350** is disposed on sole **330** below and proximal to toe friction pad **340** and extends downward toward heel **302** preferably between 1.0 and 3.0 inches and from one side **303** across the entire width of sole **330** to the other side **304**.

Second friction pad **355** is disposed on sole **330** below and proximal to first friction pad **350** and extends downward toward heel **302** preferably between 1.0 and 3.0 inches and from proximal to one side **303** across the entire width of sole **330** proximal to the other side **304**. Third friction pad **360** is disposed on sole **330** below and proximal to second friction pad **355** and extends downward toward heel **302** preferably between 1.0 and 3.0 inches and from proximal to one side **303** across the entire width of sole **330** proximal to the other side **304**. Though shown in the present embodiment with four friction pads **340**, **350**, **355**, **360**, in other embodiments, forefoot section **335** may comprise three or fewer friction pads of varying sizes. In yet other embodiments, forefoot section **335** may comprise five or more friction pads of varying sizes.

Still referring to FIG. **8**, midfoot section **365** comprises the portion of the shoe covering **300** that supports the arch of the wearer's foot. As shown in FIG. **8**, in this embodiment, midfoot section **365** does not comprise any friction pads. However, in other embodiments, midfoot section **365** may comprise one or more friction pads of varying sizes.

Hindfoot section **375** comprises heel friction pad **345** and a fourth and fifth hindfoot pad **380**, **385**, respectively. Heel friction pad **345** is disposed on the bottom of sole **330** proximal to the heel **302** or the lower end of sole **330**. Heel friction pad **345** extends from the bottom of heel **302** upward toward toe **301** preferably between 0.5 and 1.5 inches and from one side **303** across the entire width of sole **330** to the other side **304**. Fourth friction pad **380** is disposed on sole **330** above and proximal to heel friction pad **345** and extends upward toward toe **301** preferably between 1.0 and 3.0 inches and from one side **303** across the entire width of sole **330** to the other side **304**. Fifth friction pad **385** is disposed on sole **330** above and proximal to fourth friction pad **380** and extends upward toward toe **301** preferably between 1.0 and 3.0 inches and from proximal to one side **303** across the entire width of sole **330** proximal to the other side **304**. Though shown in the present embodiment with three friction pads **345**, **380**, **385**, in other embodiments, hindfoot section **375** may comprise two or fewer friction pads of varying sizes. In yet other embodiments, hindfoot section **375** may comprise four or more friction pads of varying sizes.

All friction pads **340**, **345**, **350**, **355**, **360**, **380**, **385** have a thickness preferably between 0.1 and 1.0 inch. Though friction pads **340-360**, **380-385** are shown in the present embodiment as extending from one side **303** across the entire width of sole **330** to the other side **304**, in other embodiments friction pads **340-360**, **380-385** may extend across only a portion of sole **330** between sides **303**, **304**. Friction pads **340-360**, **380-385** may be made of any suitable material known in the art including, but not limited to, polymers, ceramics, rubber, fabric, fiber glass, or fur. Friction pads **340-360**, **380-385** are preferably made of polyethylene or polytetrafluoroethylene, and more preferably made of high density polyethylene. In another embodiment, sole **330** may comprise a layer of fur instead of friction pads.

Referring now to FIGS. **8** and **9**, shoe covering **300** further comprises an anchor pin **390** extending from the bottom surface of third friction pad **360** proximal to midfoot section **365**. Anchor pin **390** has a diameter preferably less than ½ inch, and more preferably less than ¼ inch. Anchor pin **390** extends from third friction pad **360** away from sole **330** orthogonal from the plane defined by third friction pad **360** less than 1.0 inch, and more preferably between ⅛ and ¾ inch. In another embodiment, anchor pin **390** may be disposed on first or second friction pad **350**, **355**; on midfoot **365**; on fourth or fifth friction pad **380**, **385**; or in between friction pads **340-360**, **380-385**. In yet another embodiment, anchor pin **390** may be spring-loaded and disposed in a circular housing such that in an unactuated state, the anchor pin **390** protrudes outside the housing and when pressure is placed on the anchor pin **390**, pin **390** retracts into the housing. In yet another embodiment, sole **330** may comprise a plurality of anchor pins **390** that extend from or between various friction pads away from sole **330** orthogonal from the plane defined by the friction pad preferably less than 1.0 inch. Anchor pin **390** may be made of any suitable material known in the art including, but not limited to polymers, metals, ceramics, or rubber.

Referring now to FIGS. **3***a*, **3***b*, **6***a*, **6***b*, the safety assembly **200** interfaces with platform **100** at through holes **190**. Bottom end **210***b* of vertical member **210** fits in through hole **190**. In this embodiment, vertical member **210** has a semicircle cross section sized slightly smaller than the semicircle-shaped through hole **190** that is cut out of platform section **110**. The semicircle shape of both the vertical member **210** and through hole **190** ensures the safety assembly is installed in only one orientation and prevents rotation of vertical member **210**. Horizontal bar **220**, when fully extended upward, is disposed parallel to back face **130** of platform section **110**. Horizontal bar **221**, when fully extended upward, is disposed parallel to back face **130** of adjacent platform section **110**.

Referring now to FIGS. **8** and **9**, the foot coverings **300** interface with platform **100** via the anchor pins **390** and friction pads **340-360**, **380-385**. Anchor pins **390** fit in channels **180**, allowing the friction pads **340-360**, **380-385** to contact the upper surface **160** of platform **100**. Because upper surface **160** is inclined, the friction pads **340-360**, **380-385** will slide downward toward the center zone **170** under the force of gravity. The ease or amount of sliding of the pads **340-360**, **380-385** on platform surface **160** will depend on the coefficient of friction between the pads **340-360**, **380-385** and surface **160**. The coefficient of friction may vary depending on the material chosen for both the platform surface **160** and the pads **340-360**, **380-385**. Thus, the material for friction pads may be selected based upon the desired coefficient of friction.

Friction pads **340-360**, **380-385** are preferably made of a material having a coefficient of dry friction with platform surface **160** less than or equal 0.40 or a coefficient of lubricated friction with platform surface **160** less than or equal to 0.25. Moreover, each friction pad **340-360**, **380-385** may, but need not have different coefficients of friction. Different coefficients of friction may be attained for different portions of the overshoe sole **330** by changing the materials of each friction pad **340-360**, **380-385**. Thus, the coefficient of friction of the individual friction pads **340-360**, **380-385** may vary between each friction pad allowing the toe and heel friction pads **340**, **345**, for example, to have a greater coefficient of friction than the interior first, second, third, fourth, and fifth friction pads **350**, **355**, **360**, **380**, **385**. Increasing the coefficient of friction between the toe and heel friction pads **340**, **345** and the platform surface **160**, allows for greater stability by reducing the sliding effect when either the heel strikes or the toe lifts off the platform surface **160**.

The use of a lubricant can further decrease the coefficient of friction between the pads **340-360**, **380-385** and platform surface **160**. Lubricants standard in the art may be used, including but not limited to silicone wipes or oil-based sprays.

To utilize the locomotion system **10**, the user dons the foot coverings **300** on both feet and steps onto the platform **100**.

If all the horizontal bars **220**, **221** have been actuated or raised to their fully extended and horizontal position, the user will need to lower two horizontal bars **220**, **221** whose outside ends **220***a*, **221***a* are proximal to each other by actuating the release button on each corresponding vertical member **210**. The user can then step onto platform **100** and step onto the center zone **170**. The user then actuates all horizontal bars **220**, **221** that are not fully extended and horizontal or subhorizontal by sliding the second end **230***b*, **231***b* of each support bar **230**, **231** upward until second end **230***b*, **231***b* engages the coupling mechanism. The user will then employ the virtual reality device of his/her choice. Once in the virtual environment, any movement in the physical world made by the user will translate to movement in the virtual world.

The user may exercise freedom of movement while on platform **100**. When the user takes a first step with a first leg off the center zone **170** and onto the angled portion **161** of top surface **160**, the anchor pin **390** on the underside of foot covering **300** engages a channel or groove **180** on angled surface **161**. As the user takes a second step with his/her second leg, the force of gravity with the anchor pin **390**, which is slightly smaller in diameter and shorter in length than each channel **180**, guides the user's first foot down the incline of angled surface **161** toward center zone **170**. The low coefficient of friction between the foot covering pads **340-360**, **380-385** and the platform surface **160** allows the foot covering to slide on surface **160**. The anchor pin **390** on the user's second foot covering **300** then engages a channel **180** and the process is repeated. The user is thus able to maintain continuous walking motion in the virtual world while only moving within the perimeter of platform **100**.

While the user is walking on the locomotion platform **100**, the anchor pin **390** may not always engage a channel **180** upon initial contact with the platform **100**. When this occurs, the incline of angled surface **161** and the force of gravity will still cause the foot covering pads **340-360**, **380-385** to slide downward toward center zone **170**. As the foot coverings **300** are sliding down angled surface **161**, the anchor pin **390** will fall into a channel **180**, further guiding the foot covering toward center zone **170**. The anchor pin **390** will fall into a channel **180** because the space between the channels **180** is decreasing from the back edge **161***b* of angled surface **161** to center zone **170**.

Referring now to FIG. **10**, another embodiment of a locomotion system **40** in accordance with the principles described herein is shown. In this embodiment, locomotion system **40** includes a platform **400**, a platform connection structure **500** (shown in FIGS. **14** and **17***a*), a base **600**, a harness support assembly **700**, a safety harness **800**, and variable-friction shoes or foot coverings **900** (shown in FIG. **22**).

Referring now to FIG. **11**, in this embodiment, platform **400** has a vertical central axis **405** and comprises eight circumferentially adjacent generally trapezoidal sections **410** disposed about a center section or zone **470**. Each section **410** has a planar bottom or lower surface **420**, a planar back face **430** opposite a planar inner face **475**, a planar left side face **440**, and a planar right side face **450**, and a top or upper surface **460**. Faces **430**, **440**, **450** extend perpendicularly upward from lower surface **420**, and as will be described in more detail below, an outer portion of upper surface **460** is oriented at an acute angle relative to lower surface **420**. Platform sections **410** are arranged circumferentially adjacent one another such that the entirety of each left face **440** abuts the entirety of a right face **450** of an adjacent section **410**.

Center zone **470** comprises a top face **470***a* opposite a bottom face **470***c* and eight equilateral side faces **470***b* disposed at equal internal angles from each other. Since center zone **470** is both equilateral and equiangular, center zone **470** is a regular polygon-having all sides the same length that are symmetrically placed about a common central point. As previously described, platform sections **410** are disposed about center zone **470** such that the entirety of each inner face **475** abuts the entirety of a side face **470***b* of the center zone **470**. Since all platform sections **410** are identical in this embodiment, platform **400** is also a regular polygon. Platform **400** preferably has a diameter or maximum horizontal width between 3.0 and 6.0 feet, and more preferably between 3.5 and 4.5 feet.

Because eight sections **110** are provided in this embodiment, when all platform sections **410** are properly aligned, platform **400** forms an octagonal shape. However, in other embodiments, different numbers of platform sections (e.g., sections **410**) may be provided, resulting in different geometries for platform **400**. For example, a platform having six circumferentially adjacent sections will have a hexagonal shape.

Referring now to FIGS. **12***a*, **12***b*, **13***a*, and **13***b*, each section **410** includes a plurality of channels or grooves **480** disposed on upper surface **460**, two channels **490**, **491** disposed on bottom surface **420**, three extension loops **443** disposed on left side **440**, three tabs **453** disposed on right side **450**, and two slots **477** disposed on inner face **475**. Sections **410** each have a length L_{410} (measured horizontally from inner face **475** to back face **430**) preferably between 12.0 and 18.0 inches; a back width W_{410} (as measured horizontally along back face **430** between the left and right side faces **440**, **450**, respectively) preferably between 16.0 and 21.0 inches; an inner width W_{475} (as measured horizontally along inner face **475** between the left and right side faces **440**, **450**, respectively) preferably between 6.0 and 8.0 inches; a back height H_{410} (as measured vertically between the top and bottom faces **460**, **420** along the back face **430**) preferably between 2.0 and 12.0 inches; and an inner height H_{475} (as measured vertically between the top and bottom faces **460**, **420** along the inner face **475**) preferably between 0.2 and 2.0 inches. Each section **410** is constructed from a single material that has a low coefficient of friction, such as high density polyethylene, low density polyethylene, polyvinyl chloride, polypropylene, or any other suitable material with a low coefficient of friction.

Referring still to FIGS. **12***a* and **12***b*, bottom face **420** lies in a plane perpendicular to central axis **405**, is trapezoidal with back face **430** parallel to inner face **475**. When describing the individual sections **410** of platform **400**, the terms "inner" and "outer" are used in reference to the assembled platform **400** as shown in FIG. **10** where the outer edges of the platform **400** coincide with the back face **430** of each section **410** and the center of platform **400** coincides with the center of center zone **470**, which is coaxial with central axis **405**.

Back face **430** lies in a plane oriented perpendicular to bottom face **420**, extends from bottom face **420** axially upward to upper surface **460**, and has upper edge **430***a*, lower edge **430***b*, left edge **430***c*, and right edge **430***d*. The left and right side faces **440**, **450**, also oriented perpendicular to bottom face **420**, extend from left and right edges **430***c*, **430***d*, respectively, of back face **430** and terminate at inner face **475**. Inner face **475** has upper edge **475***a* and lower edge **475***b*. In the present embodiment, the angle A_{445} between the left and right side faces **440**, **450**, respectively, is 45 degrees. It should be appreciated that angle A_{445} is dependent upon the number of sections **410** used to form platform **400**. For example, as previously discussed, in an embodiment, platform **400** may be made up of six sections **410**, then angle A_{445} would be 60 degrees. In another embodiment, platform **400** may be made up of nine sections **410** with an angle A_{445} of 40 degrees.

Referring now to FIGS. **13***a* and **13***b*, platform top surface **460** includes back edge **460***b*, which is coincident with back face edge **430***a*; and front edge **460***c*, which is coincident with inner upper edge **475***a* and parallel to back edge **460***b*. Top face **460** lies in a plane and extends from outer edge **430***a*, **460***b* radially inward and axially downward toward inner edge **460***c*, **475***a* such that the angle A_{460} between the plane defined by top face **460** and the plane defined by center zone top face **470***a* is preferably between 5.0 and 18.0 degrees. In an alternative embodiment, shown in FIG. **13***b*, top surface **460** comprises top face **462***a*, back edge **462***b*, which is coincident with back face edge **430***a*; and front edge **462***c*, which is coincident with inner upper edge **475***a* and parallel to back edge **460***b*. Top face **462***a* defines a curved surface that extends from outer edge **462***b* radially inward and axially downward toward inner edge **475***a* while bulging downward toward bottom face **420**.

Referring now to FIG. **12***a*, top surface **460** also includes a plurality of channels or grooves **480** and ridges **485** that extend radially between back face **430** and inner edge **475**. The channels **480** of the present embodiment may have any geometry previously described or shown in FIGS. **5***a*-**5***d*. Like numbers are used to designate like parts. Further, the grooves **480** may become more shallow and tapered at the ends proximate the back face **430** and the inner face **475**. In another embodiment, top surface **460** may include no channels or grooves and instead has a smooth surface.

Each section **410** preferably comprises 16-18 channels **480**; however, the quantity of channels **480** will vary depending on the dimensions of each section **410** including the center zone **470** and the width of each channel **480**. Similarly, the quantity of ridges **485** will also vary depending on the quantity and dimensions of the channels **480** as well as the dimensions of each section **410**.

Referring now to FIGS. **12***a* and **12***b*, two channels or cutouts, an outer and inner channel **490**, **491**, respectively, are formed in bottom surface **420** and extend between and through the left and right side faces **440**, **450**, respectively. Channels **490**, **491** are disposed parallel to each other and parallel to back and inner faces **430**, **475**, respectively. Outer channel **490** is disposed proximate the back face **430**, and inner channel **491** is disposed proximate the inner face **475**, each channel **490**, **491** extending axially upward from bottom surface **420** toward upper surface **460**. Outer channel **490** is generally T-shaped having a back face **490***a* opposite a front face **490***b*, and an upper surface **490***c* disposed between and connecting back and front faces **490***a*, **490***b*, respectively. Extension **490***d* of outer channel **490** is disposed on back face **430** and extends from lower edge **430***b* axially upward toward upper edge **430***a*, comprises left face **490***e* opposite right face **490***f* and an upper surface **490***g* disposed between and connecting left and right faces **490***e*, **490***f*, respectively. Extension **490***d* perpendicularly intersects back face **490***a* to form a T-shaped channel in bottom surface **420**.

Outer channel **490** has a width W_{490} (as measured horizontally along bottom face **420** between the left and right side faces **490***a*, **490***b*, respectively) preferably between 5.0 and 7.0 inches; and a height H_{490} (as measured vertically between the bottom face **420** and upper surface **490***c* along the left face **440**) preferably between 1.0 and 6.0 inches. Portion **490***d* of outer channel **490** has a width W_{490d} (as measured horizontally along bottom face **420** between the left and right side faces **440***e*, **440***f*, respectively) preferably between 2.0 and 5.0 inches; and a height H_{490d} (as measured vertically between the bottom face **420** and upper surface **490***g* along the back face **430**) preferably between 1.0 and 6.0 inches. In the present embodiment, extension **490***d* of outer channel **490** is disposed approximately equidistant from left and right sides **440**, **450**, respectively. In other embodiments, extension **490***d* may be disposed closer to left side **440** or closer to right side **450**.

Referring still to FIGS. **12***a* and **12***b*, inner channel **491** has a back face **491***a* opposite a front face **491***b*, and an upper surface **491***c* disposed between and connecting back and front faces **491***a*, **491***b*, respectively. Inner channel **491** has a width W_{491} (as measured horizontally along bottom face **420** between the left and right side faces **491***a*, **491***b*, respectively) preferably between 2.0 and 9.0 inches; and a height H_{491} (as measured vertically between the bottom face **420** and upper surface **491***c* along the left face **440**) preferably between 0.2 and 2.0 inches. In the present embodiment, outer channel **490** has a smaller width W_{490} than width W_{491} of inner channel **491**, and outer channel **490** has a larger height H_{490} than height H_{491} of inner channel **491**. In other embodiments, outer channel **490** may have a larger width W_{490} than width W_{491} and/or a smaller height H_{490} than height H_{491}. Further, channels **490**, **491** may be distributed along left and right sides **440**, **450**, respectively, symmetrically or asymmetrically (shown). In other embodiments, only one channel may be used or more than two channels.

Referring now to FIG. **12***b*, three extension loops **443** are disposed on left side **440** proximate bottom surface **420**. Each extension loop **443** has an upper face **443***a* opposite a lower face **443***b*, is generally cuboid, extends from left side **440** radially outward, and has a through hole **443***c* that extends from upper face **443***a* to lower face **443***b*. In the present embodiment, one extension loop **443** is disposed proximate back face **430**, one extension loop **443** is disposed proximate inner face **475**, and one extension loop **443** is disposed between the inner and outer channels **491**, **490**. In an alternative embodiment, two extension loops may be used in any combination of locations. In other embodiments, one or more extension loops may be employed.

Referring now to FIG. **12***a*, three tabs **453** are disposed on right side **450** proximate bottom surface **420**. Each tab **453** comprises an L-shaped portion **453***a* disposed at the bottom of a body **453***b* that is coplanar with right side face **450**, and the sides of body **453***b* being formed by cutouts **453***c*. L-shaped portion **453***a* extends axially outward away from right side face **450**. In the present embodiment, one tab **453** is disposed proximate back face **430**, one tab **453** is disposed proximate inner face **475**, and one tab **453** is disposed between the inner and outer channels **491**, **490**. Each tab **453** on right side face **450** engages in an interlocking manner an extension loop **443** on left side face **440** of an adjacent platform section **410** until all tabs **453** have engaged all corresponding side face **450**. In an alternative embodiment, two tabs may be used in any combination of locations. In other embodiments, one or more tabs may be employed.

Referring still to FIG. **12***a*, two coplanar slots **477** are disposed on inner face **475** approximately halfway between upper surface **460** and bottom surface **420** and each slot **477** extends axially outward from inner face **475**, perpendicular to central axis **405**, toward back face **430**. In the present embodiment, one slot **477** is disposed proximate left side **440** and one slot **477** is disposed proximate right side **450**.

In an alternative embodiment, one or more slots **477** may be used in any combination of locations.

Referring now to FIG. **11**, center zone top face **470***a* is parallel to bottom face **470***c* and both top and bottom faces **470***a*, **470***c*, respectively, lie in a plane oriented perpendicular to central axis **405**. Center zone **470** has a length L_{470} (as measured horizontally between two opposed side faces **470***b*) preferably between 10.0 and 20.0 inches; a height H_{470} (as measured vertically between the top and bottom faces **470***a*, **470***c*) preferably between 0.2 and 2.0 inches; and each side face **470***b* has a width W_{470} (as measured between adjacent side faces **470***b* on the left and right) preferably between 3.0 and 8.0 inches. Though shown in the present embodiment parallel to bottom face **420**, center zone top face **470***a* may be curved such that the portion of top face **470***a* that intersects central axis **405** is disposed axially below the intersection of top face **470***a* and side faces **470***b*.

Center zone **470** further comprises two tabs **473** on each side **470***b*. Each tab **473** extends outward orthogonally from side **470***b*. In the present embodiment, tabs **473** are disposed approximately halfway between the top and bottom faces **470***a*, **470***c*, respectively, and spaced apart horizontally. Tabs **473** are configured such that both tabs **473** slidingly engage into corresponding slots **477** disposed in inner face **475** of platform section **410**. In other embodiments, tabs **473** may be disposed closer to either the top or bottom face **470***a*, **470***c*, respectively.

Referring now to FIGS. **14-16**, platform connection structure **500** comprises eight circumferentially adjacent generally trapezoidal connection plates **510** disposed about central axis **405**. Each plate **510** further comprises a top face **560** opposite a bottom face **520**, a left side wall **540** and a right side wall **550**. Plate **510** further comprises six through holes **575** distributed across top face **560** that extend axially downward through to bottom face **520**. Through holes **575** may all have the same diameter or may have differing diameters. Through holes **575** allow fasteners **585** to pass therethrough. In general, any fastener known in the art, including but not limited to screws (shown in FIGS. **14** and **16**), nuts and bolts, snap fit fasteners, and press fit fasteners may be used. Connection plates **510** may be made of any suitable material known in the art, including but not limited to metals or polymers.

Each plate **510** is configured to fit within inner channel **491** such that top face **560** of connection plate **510** abuts inner channel upper surface **491***c*, left side wall **540** of connection plate **510** is disposed proximate left side face **440** of platform section **410**, and right side wall **550** of connection plate **510** is disposed proximate right side face **450** of platform section **410**. Fasteners **585** then secure plate **510** to platform section inner channel **491**.

Still referring to FIGS. **14-16**, left side wall **540** comprises an upper edge **540***a* opposite a lower edge **540***b*, and a back edge **540***c* opposite an inner edge **540***d*. Left side wall **540** extends axially downward from top face **560** to lower edge **540***b*, and has two through holes **545** disposed approximately halfway between upper and lower edges **540***a*, **540***b*, respectively. In the present embodiment, through holes **545** are approximately equidistantly distributed horizontally across left side wall **540**. In other embodiments, through holes **545** may be positioned in any suitable configurations known in the art.

Similarly, right side wall **550** comprises an upper edge **550***a* opposite a lower edge **550***b*, and a back edge **550***c* opposite an inner edge **550**. Right side wall **550** extends axially downward from top face **560** to lower edge **550***b*, and has two through holes **555** disposed approximately halfway between upper and lower edges **550***a*, **550***b*, respectively. In the present embodiment, through holes **555** are approximately equidistantly distributed horizontally across left side wall **550**. In other embodiments, through holes **555** may be positioned in any suitable configurations known in the art.

Still referring to FIGS. **14-16**, through holes **545**, **555** are positioned on left and right side walls **540**, **550**, respectively, such that when a left side wall **540** of one connection plate **510** abuts a right side wall **550** of another connection plate **510**, through holes **545**, **555** on both the left and right side walls **540**, **550**, respectively, are aligned and allow a fastener **565** to pass therethrough. Any fastener known in the art, including but not limited to nut and bolt fasteners (shown in FIG. **16**), screws, snap fit fasteners, and press fit fasteners may be used. After each plate **510** is installed in platform section inner channel **491** and secured with fasteners **585**, as previously described, each plate left side wall **540** is secured to the plate right side wall **550** of an adjacent platform section **410** until all platform section **410** are secured together.

In the present embodiment, the angle A_{510} between the adjacent connection plates **510** is 135 degrees. It should be appreciated that angle A_{510} is dependent upon the number of connection plates **510** used to form platform connection structure **500**. For example, in an embodiment, platform connection structure **500** may be made up of six sections **510**, then angle A_{510} would be 120 degrees. In another embodiment, platform connection structure **500** may be made up of nine sections **510** with an angle A_{510} of 140 degrees.

Referring now to FIGS. **14** and **17***a*, base **600** comprises eight tubular members **610** having a rectangular cross section and connected to each other with eight angular connectors **620** and fasteners **635**. Each tubular member **610** has an upper face **610***a* opposite a bottom face **610***b*, a left end **610***c* opposite a right end **610***d*, and an inside face **610***e* opposite an outside face **610***f*. Each tubular member **610** has two bore holes **611** disposed on upper face **610***a* proximate left end **610***c* and two bore holes **611** disposed on upper face **610***a* proximate right end **610***d*. All tubular members **610** generally have the same overall dimensions, including the dimensions positioning the boreholes **611**. Tubular member **610** may be made of any suitable material known in the art, including but not limited to metals or polymers.

Referring now to FIG. **18**, each angular connector **620** comprises a central angular body **623**, a generally cuboid left insert **627**, a generally cuboid right insert **629**, and a foot pad **630** (see FIG. **17***a*). Central angular body **623** has a top face **621** opposite a bottom face **622**, an outer angular side **624** having a left half **624***a* and a right half **624***b*, and an inner angular side **625** having a left half **625***a* and a right half **625***b*. Body top face **621** has a left edge **621***a* and a right edge **621***b*; and body bottom face **622** has a left edge **622***a* and a right edge **622***b*. Angular connector **620** may be made of any suitable material known in the art, including but not limited to metals or polymers. Foot pad **630** may be made of any suitable material known in the art, including but not limited to rubbers or polymers.

Referring now to FIGS. **14** and **18**, in the present embodiment, the angle A_{624} of the bend in each angular connector **620** (i.e., the angle A_{624} between the left half **625***a* and right half **624***b* of angular side **624**) is 135 degrees. It should be appreciated that angle A_{624} is dependent upon the number of tubular members **610** used to form base **600**. For example, in an embodiment, base **600** may be made up of six tubular members **610**, then angle A_{624} would be 120 degrees. In another embodiment, base **600** may be made up of nine tubular members **610** with an angle A_{624} of 140 degrees.

Left insert **627** has a top face **627***a* opposite a bottom face **627***b*, an end face **627***c* disposed orthogonal to and extending between top and bottom faces **627***a*, **627***b*, respectively, and an outer side face **627***d* opposite inner side face **627***e* disposed orthogonal to and extending between top and bottom faces **627***a*, **627***b*, respectively. Left insert **627** further comprises two bores **615** in top face **627***a* disposed approximately halfway between left edge **621***a* and end face **627***c*; one bore **615** disposed proximate outer side face **627***d*, and one bore disposed proximate inner side face **627***e*. Further, left insert **627** has slightly smaller dimensions such that a lip **613** is formed around the entire interface between the left insert **627** and the central angular body **623** (i.e., lip **613** is formed at the interfaces of (1) top face **627***a* and left edge **621***a*; (2) bottom face **627***b* and left edge **622***a*; (3) outer side face **627***d* and outer angular left half **624***a*; and (4) inner side face **627***e* and inner angular left half **625***a*).

Referring now to FIG. **18**, right insert **629** has a top face **629***a* opposite a bottom face **629***b*, an end face **629***c* disposed orthogonal to and extending between top and bottom faces **627***a*, **627***b*, respectively, and an outer side face **629***d* opposite inner side face **629***e* disposed orthogonal to and extending between top and bottom faces **627***a*, **627***b*, respectively. Right insert **629** further comprises two bores **615** in top face **629***a* disposed approximately halfway between right edge **621***b* and end face **629***c*; one bore **615** disposed proximate outer side face **629***d*, and one bore disposed proximate inner side face **629***e*. Further, right insert **629** has slightly smaller dimensions such that a lip **613** is formed around the entire interface between the right insert **629** and the central angular body **623** (i.e., lip **613** is formed at the interfaces of (1) top face **629***a* and right edge **621***b*; (2) bottom face **629***b* and right edge **622***b*; (3) outer side face **629***d* and outer angular right half **624***b*; and (4) inner side face **629***e* and inner angular right half **625***b*).

Referring still to FIGS. **14** and **18**, in the present embodiment, the left and right inserts **627**, **629**, respectively, of each angular connector **620** slidingly engage the right and left ends **610***d*, **610***c*, respectively, of each tubular member **610**, such that an octagon shape is formed. Each left insert **627** is configured to slide into a tubular right end **610***d*, such that bores **611** of tubular members **610** align with bores **615** of angular connector **620**. A fastener **635** is then inserted into the aligned bores **611**, **615** to secure the angular connector **620** to the tubular member **610**. The right inserts **629** are similarly configured to slide into the tubular left end **610***c*, such that bores **611** of tubular members **610** align with bores **615** of angular connector **620**. A fastener **635** is then inserted into the aligned bores **611**, **615** to secure the angular connector **620** to the tubular member **610**. Any fastener known in the art, including but not limited to screws (shown in FIGS. **14**, **17***a*, and **17***b*), snap fit fasteners, and press fit fasteners may be used. In an alternative embodiment, angular connectors **620** are welded to tubular members **610**. In the present embodiment, after all the fasteners **635** are in place and the angular connectors **620** are secured to the ends of tubular members **610**, platform **400** can then be placed on base **600**, such that base **600** is disposed in platform channel **490**.

In the present embodiment, the interface between the inserts **627**, **629** and the central angular body **623** provides a lip **613**; however in other embodiments, angular connector **620** need not comprise a lip. In the present embodiment, foot pads **630** are disposed on the bottom of angular connectors; however, in other embodiments, foot pads may be disposed on the bottom of platform sections **410**, center zone **470**, or any combination thereof.

Referring now to FIGS. **17***a* and **17***b*, in this embodiment, harness support assembly or safety harness support structure **700** includes a pair circumferentially-spaced vertical members **710**, a pair of base interfaces **720** coupling structure **700** to base **600**, a pair of connecting beams **730** extending between interfaces **720** and members **710**, a pair adjustable height beams **740** telescoping from members **710**, and a support band or halo **750** disposed between beams **740**. Each vertical member **710** is cuboid, tubular, and has an inside face **710***a* opposite an outside face **710***b*, a left face **710***c* opposite a right face **710***d*, and an open top face **710***e* opposite an open bottom face **710***f*. Vertical members **710** further comprise a plurality of through holes **715** that extend between and through the inside and outside faces **710***a*, **710***b*, respectively. Through bores **715** are disposed horizontally halfway between left and right faces **710***c*, **710***d*, respectively, and are vertically spaced evenly apart. Vertical members **710** may be made of any suitable material known in the art, including but not limited to metals or polymers.

Each base interface **720** is cuboid, tubular, and has an inside face **720***a* opposite an outside face **720***b*, an open left face **720***c* opposite an open right face **720***d*, and a top face **720***e* opposite a bottom face **720***f*. Base interfaces **720** further comprise four bores **725** that extend axially downward from top face **720***e*, each bore **725** disposed proximate one of the four corners of top face **720***e*. The dimensions of base interface **720** are slightly larger than that of tubular member **610** to allow base interface **720** to slide over tubular member **610**. Fasteners **728** secure base interface to base tubular member **610**. Base interfaces **720** may be made of any suitable material known in the art, including but not limited to metals or polymers. Any fastener known in the art including, but not limited to, nut and bolt fasteners, screws (shown in FIGS. **17***a* and **17***b*), snap fit fasteners, and press fit fasteners may be used. In an alternative embodiment, base interfaces **720** are welded to tubular members **610**.

Referring still to FIGS. **17***a* and **17***b*, vertical tubular **710** is connected to base interface **720** through connecting beam **730**. Connecting beam **730** is cuboid and has an inside face **730***a* opposite an outside face **730***b*, a left face **730***c* opposite a right face **730***d*, and a top face **730***e* opposite a bottom face **730***f*. Connecting beam outside face **730***b* is connected to vertical tubular inside face **710***a* and connecting beam inside face **730***a* is connected to base interface outside face **720***b*. Connecting beam **730** may be connected to vertical tubular **710** and base interface **720** using any fastening means known in the art, including but not limited to welding, nut and bolt fasteners, screws, snap fit fasteners, and press fit fasteners. In another embodiment, vertical tubular **710**, connecting beam **730**, and base interface **720** may be monolithic or formed from one piece of material. Connecting beam **730** may be tubular or solid and may be made of any suitable material known in the art, including but not limited to metals or polymers.

Each adjustable height beam **740** is tubular and comprises three portions—an adjustor portion **742**, an angled portion **744**, and a ring interface portion **746**. Adjustor portion **742** is cuboid, tubular, and has an inside face **742***a* opposite an outside face **742***b*, a left face **742***c* opposite a right face **742***d*, and an open bottom face **710***f*. Each adjustable portion **742** further comprises a plurality of through holes **745** that extend between and through the inside and outside faces **742***a*, **742***b*, respectively. Through bores **715** are disposed horizontally halfway between left and right faces **742***c*, 742*d*, respectively, and are vertically spaced evenly apart. Adjustor portion **742** is disposed inside vertical tubular **710** and through holes **745** are positioned on adjustor portion **742** such that the vertical distance between each through hole **745** is equivalent to the vertical distance between the through holes **715** in vertical tubular **710**, whereby the raising or lowering of adjustable height beam **740** in vertical tubular **710** allows through holes **715**, **745** to become aligned. Once through holes **715**, **745** of the vertical tubular **710** and the adjustable portion **742**, respectively, are aligned, a locking mechanism **718** can be inserted in through the aligned through bores **715**, **745**. Angled portion **744** is tubular and extends axially upward and radially inward from adjustor portion **742** toward support halo **750**. Ring interface portion **746** extends axially upward from the top of angled portion and is connected to support halo **750**. Ringer interface portion **746** may be connected to support halo **750** using any fastening means known in the art, including but not limited to screws, nuts and bolts, snap fit fasteners, and press fit fasteners. Vertical members **710** may be made of any suitable material known in the art including, but not limited to, metals or polymers. Any locking mechanism **718** known in the art, including, but not limited to, a lock pin, a ball pin, and nut and bolt fasteners may be used. In an alternative embodiment, two or more locking mechanisms **718** may be inserted through two or more aligned through bores **715**, **745**.

Referring now to FIGS. **17***a*, **17***b*, **19**, and **20**, ring interface portions **746** (and entire adjustable height beam **740**) are connected to and disposed about support halo **750** at angle A_{740}, the angle A_{740} defined by the planes that vertically bisect the inside face **710***a* of each vertical member **710**, that is preferable 135.0 degrees. In other embodiments, this angle A_{740} may be 180.0 degrees or smaller, depending on the number of platform sections **410** used, for example. The overall height H_{750} (as measured vertically between the vertical tubular bottom face **710***f* and top surface support ring top surface **750***a*) of the support ring **750** can be adjusted as previously described to accommodate the different heights of the user. The range in support ring height H_{491} is preferably between 30.0 and 50.0 inches. In this embodiment, support halo **750** is a closed loop structure designed to extend completely around the user. To accommodate the user, support halo **70** preferably has a minimum inner width W_{750} between 15 and 25 inches. Although halo **750** is a closed structure that extends completely around the user in this embodiment, in other embodiments, the support halo (e.g., support halo **750**) can be an open structure that extends partially around the user (e.g., C-shaped).

Referring now to FIGS. **17***a*, **17***b*, **20**, and **21**, support halo **750** extends about a vertical central axis **705** and has a top surface **750***a* opposite a bottom surface **750***b*, and inner surface **750***c* opposite an outer surface **750***d*. In this embodiment, support halo **750** is an annular ring, and thus, may also be referred to as support ring **750**. It should be appreciated that since support ring **750** is annular in this embodiment, minimum inner width W_{750} is an inner diameter D_{750}. Although support halo **750** is annular in this embodiment, in other embodiments, the support halo (e.g., support halo **750**) can have other geometries such as oval, ovoid, rectangular, square, etc.

Support ring **750** further comprises a support structure **753**, a lower ring **755**, an upper ring **757**, and a door **759** with a latch **760** and a hinge **765**. In the present embodiment, support structure **753** provides rigidity as well as a structure on which to attach the lower and upper rings **755**, **757**, respectively. When door **759** is closed, support structure **753** overlaps the support structure **753** in the support ring **750**, allowing the support ring **750** to support a load. Support structure **753** may be made of any suitable material known in the art including, but not limited to, metals or polymers, and is preferably made of high-density polyethylene (HDPE). Lower ring **755** has a U-shaped cross section and is attached to support structure **753** to form the bottom surface **750***b* and the lower part of both inner and outer surfaces **750***c*, **750***d*, respectively. Upper ring **757** has an inverted U-shaped cross section and is attached to support structure **753** to form the top surface **750***a* and the upper part of both inner and outer surfaces **750***c*, **750***d*, respectively. Lower and upper rings **755**, **757**, respectively, also comprise cutouts **756** to accommodate any suitable fastening device known in the art including, but not limited to screws, snap fit fasteners, and press fit fasteners. Lower and upper rings **755**, **757**, respectively, may be made of any suitable material known in the art, including but not limited to polymers.

Door **759** comprises a portion of support ring **750** that is movable by horizontally pivoting at hinge **765** along an axis parallel to central axis **405**. Hinge **765** in combination with a pin **766** may employ any suitable means known in the art, including but not limited to a ball pin, a lock pin, and a quick release pin. When in the closed position, latch **760** engages a lock plate **761** disposed on the stationary portion of support ring **750**.

Referring now to FIGS. **10** and **22**, safety harness **800** comprises a generally U-shaped bar **810**, a pair of mounting members **820**, a pair of vertical members **830**, a waist belt **840**, and two interface structures **850**. U-shaped bar **810** is tubular and lies in a plane orthogonal to central axis **405**. At each end of U-shaped bar **810**, a mounting member **820** extends radially outward from U-shaped bar **810**; and a vertical member **830** extends axially downward from the mounting member **820**. In the present embodiment, mounting member **820** is a square tubular bar and vertical member **830** is a vertical tubular bar that further comprises a vertical contact structure **835**. Mounting member **820** and vertical member **830** may be made of any suitable material known in the art, including but not limited to metals and polymers. In the present embodiment, vertical contact structure or glide pad **835** is fastened to an exterior side of vertical member **830** with nuts and bolts. Vertical contact structure **835** may be made of any suitable material known in the art, including but not limited to polymers, and is preferably made of HDPE. A waist belt **840** is fixably attached to the U-shaped bar **810** on each of the interior sides of the U-shaped cross section. Waist belt **840** may be attached to bar **810** using any means standard in the art including, but not limited to, hook and loop fasteners, buttons, nuts and bolts, screws, and adhesives. Waist belt **840** may be attached directly to bar **810** or may be attached to a bracket **815** (FIG. **22**) that is then attached to the bar **810**.

Referring now to FIG. **22**, an interface structure **850** is disposed on each mounting member **820**. Each interface structure **850** has a tubular bore **851** disposed in the center portion of interface structure **850** that slidingly engages mounting member **820**. Interface structure **850** comprises a low horizontal contact structure or glide pad **853** and a high horizontal contact structure or glide pad **857** that are installed opposite each other, thus, when high horizontal contact structure **857** is facing upward, low horizontal contact structure **853** is facing downward toward platform **400** and vice versa. The distance D_{857} from the center of tubular bore **851** vertically upward to high horizontal contact structure **857** is greater than the distance D_{853} from the center of tubular bore **851** vertically downward to low horizontal contact structure **853**. The difference in distance D_{853}, D_{857} allows for an additional level of height adjustment when the interface structure **850** is reversed. In the present embodiment, horizontal glide pads **853**, **857** are fastened to opposite exterior sides of interface structures **850** with nuts and bolts. Interface structure **850** has a length L_{850} preferably between 4.0 and 10.0 inches and a height (D_{853} plus D_{857}) preferably between 2.0 and 8.0 inches. Horizontal glide pads **853**, **857** may be made of any suitable material known in the art, including but not limited to polymers, and is preferably made of HDPE. Interface structure **850** is secured to mounting member **820** with a locking mechanism **865**. Locking mechanism **865** may be any fastener known in the art, including, but not limited to, a lock pin, a ball pin, and nut and bolt fasteners may be used.

During use, harness **800** is placed in support ring **750** such that interface structures **850** slidingly engage the support ring **750** and can move circumferentially and radially relative to the support ring **750**. Further, horizontal glide pads **853**, **857** (either low or high, respectively) rest on and are in contact with top surface **750***a* and vertical contact structure **835** is disposed within inside surface **750***c* of support ring **750** allow ease in maneuverability of the user. The user may move up and down above the support ring **750** such that the interface structures **850** no longer engage the support ring **750** and the vertical contact structure **835** may or may not remain disposed within the inside surface **750***c* of support ring **750**. As previously described, support ring **750** and contact structures are all made of polymers, which allows the contact structures **835**, **853**, **857** to slide on support ring **750**.

Referring now to FIG. **23**, an embodiment of a foot covering **900** for use with embodiments of locomotion systems and platforms described herein is shown. In this embodiment, foot covering **900** comprises an upper portion **910**, a sole **930**, and a plurality of variable friction pads **940-960**, **980**. As used herein, the term “foot covering” refers to a shoe or an overshoe. An overshoe is a foot covering that at least partially covers the wearer’s shoe and generally includes a sole and a means to attach the sole to the wearer’s shoe or body (e.g., foot, ankle, or leg). Further, when used to describe foot covering **900**, the terms “top” or “bottom” may be used for purposes of description with “up,” “upper,” “upward,” or “above” meaning generally toward or closer to the end of foot covering **900** closest to the toe **901**, and with “down,” “lower,” “downward,” or “below” meaning generally toward or closer to the end of foot covering **900** closest to the heel **902**. The overall length and width of foot covering **900** will vary depending on the size of the wearer’s foot; thus, foot covering **900** may be customized to fit any sized foot. In the present embodiment, foot covering **900** may be made of any suitable material known in the art, including but not limited to fabric, leather, or other suitable material known in the art.

Referring still to FIG. **23**, sole **930** of foot covering **900** covers the underside of the wearer’s foot and connects to upper portion **910** along the entire perimeter of the wearer’s foot. In this embodiment, upper portion **910** and sole comprise one continuous piece of material.

Sole **930** comprises three sections—a forefoot **935**, a midfoot **965**, and a hindfoot **975**. Forefoot section **935** includes toe friction pad **940** and a first, second, third, and fourth forefoot pad **945**, **950**, **955**, **960**, respectively. Toe friction pad **940** is disposed on the bottom of sole **930** proximal to the toe **901** or the “top” of sole **930**, and has two curved or cut out portions at the lower end of friction pad **940**. Toe friction pad **940** extends from the top of toe **901** downward toward heel **902** preferably between 0.5 and 2.5 inches and from one side **903** across the entire width of sole **930** to the other side **904**. Friction pad **940** may be round or any other suitable shape known in the art. Friction pad **940** may be made of any suitable material including, but not limited to, fabric, leather, or polymers. First friction pad **945** is generally circular and is disposed below and adjacent to toe friction pad **940** in one of the cut out portions at the bottom of toe friction pad **940**. First friction pad **945** has a diameter preferably between 0.4 and 2.0 inches. Second friction pad **950** is generally circular and is disposed below and adjacent to toe friction pad **940** in the other of the two cut out portions at the bottom of toe friction pad **940**. Second friction pad **950** has a diameter preferably between 0.4 and 2.0 inches. Third friction pad **955** is generally circular and is disposed on sole **930** below and proximal to first friction pad **945**. Third friction pad **955** has a diameter preferably between 0.4 and 2.0 inches. Fourth friction pad **960** is generally circular and is disposed on sole **930** below and proximal to second friction pad **950**. Fourth friction pad **960** has a diameter preferably between 0.4 and 2.0 inches. Though shown in the present embodiment with four friction pads **945**, **950**, **955**, **960**, in other embodiments, forefoot section **935** may comprise three or fewer friction pads of varying sizes. In yet other embodiments, forefoot section **935** may comprise five or more friction pads of varying sizes.

Still referring to FIG. **23**, midfoot section **965** comprises the portion of the shoe covering **900** that supports the arch of the wearer’s foot. In this embodiment, midfoot section **965** does not comprise any friction pads. However, in other embodiments, midfoot section **965** may comprise one or more friction pads of varying sizes.

Hindfoot section **975** comprises heel friction pad **980**. Fifth friction pad **980** is generally shaped like a FIG. **8** on its side, and is disposed on sole **930** approximately centered between sides **903**, **904** and proximal to the heel **902**. Fifth friction pad **980** has a width preferably between 0.4 and 2.0 inches and a height preferably between 0.4 and 2.0 inches. Though shown in the present embodiment with one friction pad **980** in other embodiments, hindfoot section **975** may comprise two or more friction pads of varying sizes and shapes.

All friction pads **940**, **945**, **950**, **955**, **960**, **980** have a thickness preferably between 0.1 and 1.0 inch. Though the majority of friction pads **940-960**, **980** are shown in the present embodiment as circular, in other embodiments friction pads **940-960**, **980** may extend from one side **903** across the entire width of sole **930** to the other side **304**. Friction pads **940-960**, **980** may be made of any suitable material known in the art including, but not limited to, polymers, ceramics, rubber, fabric, fiber glass, or fur. Friction pads **940-960**, **980** are preferably made of polyethylene or polytetrafluoroethylene, and more preferably made of high density polyethylene. In another embodiment, sole **930** may comprise a layer of fur instead of friction pads. In another embodiment, the entire foot covering **900** may comprise fur or fabric. In another embodiment, the foot coverings **900** may comprise a plastic low friction bag that wraps around the shoe of the user.

Because upper platform surface **460** is inclined, the friction pads **940-960**, **980** will slide downward toward the center zone **470** under the force of gravity. The ease or amount of sliding of the pads **940-960**, **980** on platform surface **460** will depend on the coefficient of friction between the pads **940-960**, **980** and surface **460**. The coefficient of friction may vary depending on the material chosen for both the platform surface **460** and the pads **940-960**, **980**. Thus, the material for friction pads may be selected based upon the desired coefficient of friction.

Friction pads **940-960**, **980** are preferably made of a material having a coefficient of dry friction with platform surface **460** less than or equal 0.40 or a coefficient of lubricated friction with platform surface **460** less than or equal to 0.25. Moreover, each friction pad **940-960**, **980** may, but need not have different coefficients of friction. Different coefficients of friction may be attained for different portions of the overshoe sole **930** by changing the materials of each friction pad **940-960**, **980**. Thus, the coefficient of friction of the individual friction pads **940-960**, **980** may vary between each friction pad allowing the toe friction pad **940**, for example, to have a greater coefficient of friction than the interior first, second, third, fourth, and fifth friction pads **945-960**, **980**. Increasing the coefficient of friction between the toe friction pad **940** and the platform surface **460**, allows for greater stability by reducing the sliding effect when the heel lifts off the platform surface **460**.

The use of a lubricant can further decrease the coefficient of friction between the pads **940-960**, **980** and platform surface **460**. Lubricants standard in the art may be used, including but not limited to silicone wipes or oil-based sprays.

To utilize the locomotion system **40**, the user dons the foot coverings **900** on both feet, steps onto the platform **400** and to the center zone **470**, and into support ring **750**. The user then straps on the support harness **800** and then closes and latches the door **759**. The user can then employ the virtual reality device of his/her choice. Once in the virtual environment, any movement in the physical world made by the user will translate to movement in the virtual world.

The user may exercise freedom of movement while on platform **400**. The user may take a first step with a first leg off the center zone **470** and onto the angled top surface **460**. As the user takes a second step with his/her second leg, the force of gravity guides the user's first foot down the incline of angled top surface **460** toward center zone **470**. The low coefficient of friction between the foot covering pads **940-960**, **980** and the platform surface **460** allows the foot covering **900** to slide on surface **460**, and the process is repeated. The user is thus able to maintain continuous walking motion in the virtual world while only moving within the perimeter of platform **400**.

As previously described, angled top surface **460** need not comprise any channels or grooves and still allow the user to exercise freedom of movement while on the platform **400**. However, in the preferred embodiment, angled top surface **460** does include grooves **480** as the grooves decrease the contact surface area between the platform **400** and the foot coverings **900**, guide the user's foot to the center zone **470**, prevent lateral slide, and are aesthetically pleasing.

Referring now to FIG. **24**, the locomotion system **40** described herein may be used in conjunction with a virtual reality system **1000**, which may comprise a processing unit **1200** in communication with one or more motion sensing devices **1100**, a display device **1300**, and a controller **1400**. The virtual reality system components may be separate devices or combined into one or more devices. Motion sensing devices **1100** detect, register, and track the user's motions and gestures and may be separate from the platform **400** of locomotion system **40** (shown as component **1100** in FIG. **24**), may be integrated into the platform **400** of system **40** (shown as component **1100'** in FIG. **24**), may be integrated into the controller **1400** (shown as component **100"** in FIG. **24**), may be integrated into the display device **1300** (shown as component **1100'"** in FIG. **24**), or any combination thereof, such that virtual reality system **1000** comprises motion sensing devices as a separate component **1100**, in the locomotion platform **400** of system **40** (component **1100'**), in the controller **1400** (component **1100"**), and/or in the display device (component **1100'"**). In general, any motion sensing device known in the art may be used including, without limitation, optical gesture recognition devices or devices employing inertial motion sensors, accelerometers, magnetometers, infrared or optical tracking, capacitive sensors built in the base of platform **400**, global positioning tracking, magnetic tracking, or any combination thereof, including but not limited to a Microsoft® Kinect™, Asus® Wavi Xtion™; Razer® Hydra, Sixense STEM, LEAP MOTION, MYO, INTEL PERCEPTUAL COMPUTING, Sony® PlayStation® Move, and Nintendo® Wii® Remote and Wii® Nunchuck.

The processing unit **1200** utilizes motion recognition software to process the input signals from the motion sensing devices **1100** and controller **1400**, recognize the user's motions and gestures on platform **400** of locomotion system **40**, and send output signals to a virtual environment program and to the display device **1300**. The virtual environment program comprises a game or any other three-dimensional environment software that is compatible with the processing unit **1200** and display device **1300**. The output signals the processing unit **1200** sends to the virtual environment program and the display device **1300** direct the movements and actions of the virtual representation of the user (i.e., the avatar) based on the physical motions of the user, and correspondingly change the projected view to the user, respectively. In general, any processing unit known in the art may be used including, without limitation, a personal computer, laptop, game console, smartphone, or tablet that is capable of processing graphics and running software capable of processing input from the motion sensing devices and sending output signals to the virtual environment program and display device. In an alternative embodiment, processing unit **1200** is an integral component of locomotion system **40**.

The display device **1300** provides the visual images of the virtual environment to the user. In general, any display device known in the art may be used including, without limitation, virtual reality glasses including but not limited to Oculus Rift, Vuzix® Wrap 920 VR Bundle; or projectors, screens, and CAVE environments that may or may not be integrated with the processing unit.

The virtual reality system **1000** may further comprise a wired or wireless controller **1400** to further aid in directing certain avatar actions in the virtual environment, such as a game pad or joystick (e.g., Xbox 360® controller, if compatible or made compatible with the processing unit **1200** and virtual environment program), a keyboard and mouse, a TacticalHaptics controller, a Sixense STEM controller, or a gun (such as the Wii Zapper® with the Wii Remote® and Wii Nunchuk®, if compatible or made compatible with the processing unit **1200** and virtual environment program) or other weapon peripheral. As previously discussed, in other embodiments, the controller **1400** may also comprise motion sensing devices **1100**.

It should be appreciated that the user may perform any number of movements while using locomotion system **10**, **40** including but not limited to crouching, jumping, squatting, walking, running, kneeling, standing, turning, and strafing (i.e., sideways stepping). Thus, the user can move about the virtual environment by moving unhindered in the physical world and having those movements translated to motion in the virtual environment.

As previously described, the safety harness support structure **700** comprises vertical members **710** coupled to base **600** (via coupling to tubular members **610**) and extending from the planar back face **430** of the platform **400**. However, in other embodiments, the safety harness support structure **700**A could alternatively be coupled to the platform **400**A by other means, for example as shown in FIG. **25**, vertical members **710**A are seated in mating receptacles **711** in radial outer portion **499** of section **410**A.

As previously described, the safety harness support structure **700** comprises two vertical members **710** coupled to the platform **400** (via tubular members **610** of base **600**). However, in other embodiments, the safety harness support structure **700**B could alternatively be coupled to the platform **400**B by only one vertical member **710**B, as shown in FIG. **26**.

As previously described, the door **759** comprises a portion of support ring **750** that is movable by horizontally pivoting at hinge **765** along an axis parallel to central axis **405**. However, in other embodiments, the door **759**C could alternatively be movable at hinge **765**C by pivoting outward horizontally, vertically, or a combination of both. For example, as shown in FIG. **27**, door **759**C could be moveable by vertically pivoting at hinge **765**C.

As previously described, to prevent the user from falling, the user wears a waist or support belt **840** that can be tightened around the user's waist. This waist belt **840** can comprise of additional straps that go around the user's legs, hence forming a harness. The belt **840** and the additional straps can be made of leather, fabric, or any other material, and can be tightened and closed by means of hook- and loop-fasteners or any other belt tightening and closing mechanism.

As previously described, waist belt **840** is fixably attached to the U-shaped bar **810** on each of the interior sides of the U-shaped cross section by any fastener **215** standard in the art. However, in other embodiments, waist belt **840** may be coupled directly to interface structures or flanges **850** via fasteners **815**', as shown in FIGS. **28** and **29***a*-**29***q*. In addition, safety harness **800'** may comprise three or more flanges **850'** attached to bar **810'**. For example and as is shown in FIGS. **28** and **30**, safety harness **800'** may comprise four flanges **850'**. Further, flanges **850** may be configured differently, as shown in FIGS. **28** and **29***a*-**29***q*. As previously described, interface structures or flanges **850** comprise horizontal glide pads **853**, **857** that slide on support ring **750**.

Referring now to FIGS. **29***a*-**29***q*, the position of the flanges **850**A-**850**Q is such that they are above the support ring **750**A-**750**Q, and the flanges **850**A-**850**Q are long enough to extend over the support ring **750**A-**750**Q when the user stands in the middle of the platform **400**. The flanges **850**A-**850**Q can thus never drop below the support ring **750**A-**750**Q. As such, because the flanges **850**A-**850**Q are attached to the user's waist belt **840**A-**840**Q, the user will be blocked from falling down by the flanges **850**A-**850**Q, as the flanges themselves are blocked from going down by the support ring **750**A-**750**Q.

The flanges **850**A-**850**Q can be made of metal, plastic, wood, or any other material with sufficient structural strength. They can be a solid flat surface, or round tubes, or any other shape or form that provides the desired support. The flanges **850**A-**850**Q can be attached to the belt by rivets or any other attachment mechanism that is strong enough to keep the flanges in a straight horizontal position whenever an upward force is applied to them. The user's waist belt **840**A-**840**Q can be enforced with an additional bendable ring to provide enough structural strength to keep the flanges in place and in horizontal position.

The flange of FIG. **29***a* has a hook shape **751**A, which extends vertically downward from the end flange **850**A on the outside of support ring **750**A. Like numbers are used to designate like parts. The flange **850**B of FIG. **29***b* has an additional secondary hook **752**B disposed on the inside of support ring **750**B. The flange **850**C of FIG. **29***c* has a downward sloping edge **751**C on the outside of support ring **750**C. The flange **850**D of FIG. **29***d* has a curved edge **751**D on the outside of support ring **750**D. The flange **850**E of FIG. **29***e* has only an interior hook **752**E disposed on the inside of support ring **750**E. Those hook flanges can further be attached to the belt via hinges, providing some more movement flexibility to these hooks.

Similarly, one or more flanges can be upward sloping or curved within the support ring. For example, the flange **850**F of FIG. **29***f* slopes upward on the inside of support ring **750**F and then extends horizontally past support ring **750**F. The flange **850**G of FIG. **29***g* has a hook **751**G disposed on the outside of support ring **750**G. The flange **850**H of FIG. **29***h* is curved upward on the inside of support ring **750**H and then extends horizontally past support ring **750**H. The flange **850**I of FIG. **29***i* slopes upward on the inside of and extends past support ring **750**I. The flange **850**J of FIG. **29***j* curves upward on the inside of support ring **750**J.

To allow for different waist sizes and user adjustability, the flanges can have different edges that can fit over the ring. For example, the flange **850**K of FIG. **29***k* curves in a convex manner over support ring **750**K. The flange **850**L of FIG. **29***l* slopes upward on the inside of and extends past support ring **750**L, and further comprises tabs **852**L that extend vertically downward from flange **850**L to catch support ring **750**L. The flange **850**M of FIG. **29***m* curves in a convex manner over and extends past support ring **750**M, and further comprises tabs **852**M that extend toward support ring **750**M from flange **850**M to catch support ring **750**M. The flange **850**N of FIG. **29***n* comprises a hook shape **751**N, which extends vertically downward from the end flange **850**N, and a plurality of additional hook shapes **752**N to allow a plurality of positions for hook shapes **752**N to rest around support ring **750**N. The flange **850**O of FIG. **29***o* is substantially similar to the flange of FIG. **29***n*, but with flange curving upward and having hook shapes **751**O, **752**O.

Also, the user can adjust the level of radial constraint by adjusting the position of the vertical member **830**. For example, as shown in alternative embodiment in FIG. **29***p*, moving the pin **830**P further out results in more constraint, closer to the user results in less constraint. The vertical members **830**P can be replaced by curved or upward sloping "bumpers" **752**Q, as shown in FIG. **29***q*, that are attached to the belt **840**Q, providing a closed loop. As with the vertical members **830**P, the user can adjust the top position of the bumper **830**Q, to adjust the level of constraint.

Any combination of the above is possible to provide the user with a radial movement constraint while allowing rotation, and while allowing for different user waist sizes and different levels of radial constraint. As previously described, the safety belt **840** is fixably attached to bar **810** and may be adjustable. In one embodiment, shown in FIG. **31**, bar **810"** is adjustable via an extendable connector **899**, which connects to flange or interface structure **850"**. Extendable connector **899** allows for some forward and backward flexibility of the user.

While preferred embodiments have been shown and described, modifications thereof can be made by one skilled in the art without departing from the scope or teachings herein. The embodiments described herein are exemplary only and are not limiting. Many variations and modifications of the systems, apparatus, and processes described herein are possible and are within the scope of the invention. For example, the relative dimensions of various parts, the materials from which the various parts are made, and other parameters can be varied. Accordingly, the scope of protection is not limited to the embodiments described herein, but is only limited by the claims that follow, the scope of which shall include all equivalents of the subject matter of the claims. Unless expressly stated otherwise, the steps in a method claim may be performed in any order. The recitation of identifiers such as (a), (b), (c) or (1), (2), (3) before steps in a method claim are not intended to and do not specify a particular order to the steps, but rather are used to simplify subsequent reference to such steps.

What is claimed is:

1. A locomotion system for use with a virtual environment technology, the system comprising:
- a platform;
- a harness support assembly coupled to the platform and extending upwardly from the platform, wherein the harness support assembly comprises a vertically adjustable support halo positioned above the platform and extending about a vertical central axis;
- a safety harness coupled to an interface structure configured to slidingly engage and be vertically supported by the support halo; and
- a motion sensing device in communication with a processing unit and configured to detect and track motion within the platform.

2. The system of claim **1**, wherein the support halo is disposed at a height H above the platform, and wherein the height H is between 30.0 and 50.0 in.

3. The system of claim **1**, wherein the support halo is annular.

4. The system of claim **1**, wherein the support halo is configured to extend completely about a user.

5. The system of claim **1**, wherein the support halo includes an access door.

6. The system of claim **1**, further comprising at least one foot covering configured to engage the platform, wherein the foot covering is composed of a variable friction material having a low coefficient of friction.

7. The system of claim **1**, where the motion sensing device includes a first inertial motion sensor coupled to a first of the at least one foot covering and a second inertial motion sensor coupled to a second of the at least one foot covering.

8. The system of claim **1**, wherein the harness support assembly includes a pair of circumferentially spaced connecting beams coupled to the support halo.

9. The system of claim **1**, further comprising:
- a vertical member coupled to the safety harness and is disposed within the support halo, wherein the vertical member is configured to limit radial movement of the interface structure relative to the support halo.

10. The system of claim **1**, wherein the safety harness is configured to move vertically relative to the support halo.

11. The system of claim **1**, wherein the safety harness is configured to move circumferentially relative to the support halo.

12. The system of claim **1**, wherein the safety harness is configured to move radially relative to the support halo.

13. The system of claim **1**, wherein the motion sensing device is disposed in at least one of the platform, a controller, or a display device.

14. The system of claim **1**, the motion sensing devices is selected from the group comprising an inertial motion sensor, an accelerometer, a magnetometer, an infrared sensor, an optical sensor, a capacitive sensor, a global positioning tracking device, and magnetic tracking device.

15. The system of claim **1**, further comprising a controller.

16. The system of claim **15**, wherein the motion sensing device is coupled to the controller.

17. The system of claim **1**, further comprising a visual display.

18. The system of claim **17**, wherein the motion sensing device is coupled to the visual display.

19. A locomotion system comprising:
- a platform;
- a harness support assembly coupled to the platform and including at least two vertical beams extending upwardly from the platform and coupled with a support halo, wherein the support halo is vertically adjustable and positioned above the platform extending about a vertical central axis;
- a safety harness coupled to an interface structure moveably configured to slidingly engage the support halo, wherein the interface structure is configured to move circumferentially relative to the support halo and is vertically supported by the support halo; and
- at least one motion sensing device in communication with a processing unit and configured to detect and track movement within the platform.

20. The system of claim **19**, wherein the support halo is disposed at a height H above the platform, and wherein the height H is between 30.0 and 50.0 in.

21. The system of claim **19**, wherein the support halo is annular.

22. The system of claim **19**, wherein the support halo is configured to extend completely about a user.

23. The system of claim **19**, wherein the support halo includes an access door.

24. The system of claim **19**, further comprising at least one foot covering configured to engage the platform, wherein the foot covering is composed of a variable friction material having a low coefficient of friction.

25. The system of claim **19**, where the motion sensing device includes a first inertial motion sensor coupled to a first foot covering and a second inertial motion sensor coupled to a second foot covering.

26. The system of claim **19**, wherein the harness support assembly includes a pair of circumferentially spaced connecting beams coupled to the support halo.

27. The system of claim **19**, further comprising:
- a vertical member coupled to the safety harness and is disposed within the support halo, wherein the vertical member is configured to limit radial movement of the interface structure relative to the support halo.

28. The system of claim **19**, wherein the safety harness is configured to move vertically relative to the support halo.

29. The system of claim **19**, wherein the safety harness is configured to move radially relative to the support halo.

30. The system of claim **19**, wherein the motion sensing device is disposed in at least one of the platform, a controller, or a display device.

31. The system of claim **19**, the motion sensing devices is selected from the group comprising an inertial motion sensor, an accelerometer, a magnetometer, an infrared sensor, an optical sensor, a capacitive sensor, a global positioning tracking device, and magnetic tracking device.

32. The system of claim **19**, further comprising a controller.

33. The system of claim **32**, wherein the motion sensing device is coupled to the controller.

34. The system of claim **19**, further comprising a visual display.

35. The system of claim **34**, wherein the motion sensing device is coupled to the visual display.

36. A locomotion system comprising:

a platform;

a harness support assembly coupled to and extending upwardly from the platform and coupled with a support halo; and

a safety harness coupled to an interface structure and a vertical member, wherein the interface structure is moveably configured to slidingly engage the support halo and the vertical member is disposed within the support halo is configured to limit radial movement of the interface structure relative to the support halo.

37. The system of claim **36**, further comprising at least one foot covering configured to engage the platform, wherein the foot covering is composed of a variable friction material having a low coefficient of friction.

38. The system of claim **36**, further comprising a first inertial motion sensor coupled to a first covering and a second inertial motion sensor coupled to a second foot covering.

39. The system of claim **36**, further comprising:

at least one motion sensing device in communication with a processing unit and configured to detect and track motion within the platform.

40. The system of claim **39**, wherein the at least one motion sensing device is disposed in at least one of the platform, a controller, or a display device.

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